### SEA LAMPREY SPAWNING: MICHIGAN STREAMS OF LAKE SUPERIOR

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United States Department of the Interior, Oscar L. Chapman, Secretary
Fish and Wildlife Service, Albert M. Day, Director

SEA LAMPREY SPAWNING: MICHIGAN
STREAMS OF LAKE SUPERIOR

by

Howard A. Loeb and Albert E. Hall, Jr. Fishery Research Biologists

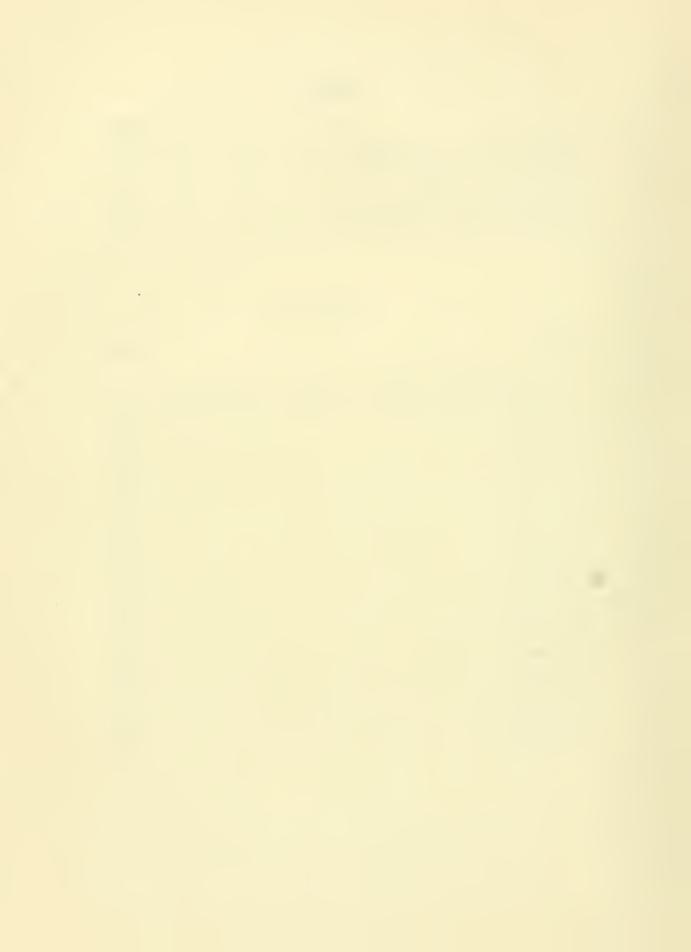


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### Introduction

During the three decades since the capture of the first specimen in Lake Erie in 1921, the sea lamprey (Petromyzon marinus) has established itself in great numbers in the upper Great Lakes. Partial destruction of the commercial and sport fisheries of Lakes Huron and Michigan has resulted. Details of the problem in those lakes have been presented in recent papers (Applegate 1950; Hile 1949; Hile et al. 1951).

The present situation in Lake Superior differs from that in Lakes Huron and Michigan in that the sea lamprey is still in its initial states of dispersal and establishment (first specimen taken at Isle Royale, 1946). The lamprey appears already to have caused some damage to the fish populations (especially lake trout) in the Superior basin. Commercial catches have declined (owing partially, perhaps, to increased fishing pressure) throughout the lake, but the greatest decrease has taken place in the eastern areas. If the relation between the fish populations and the sea lamprey follows the pattern established in Lakes Huron and Michigan, commercial fishing for lake trout and certain other species of present importance in Lake Superior will be unprofitable within three or four years.

Control of the sea lamprey in all of the lakes will probably be effected by attacking the parasite during one of the stream phases of its life cycle; for example, the upstream migrations of sexually mature individuals can be blocked by dams, mechanical weirs, and electrical barriers in streams suitable for spawning (Applegate and Smith 1951).

The relative importance of most of the watersheds of the Lake Huron and Lake Michigan basins as sea-lamprey spawning areas has been determined. Suitable spawning habitat is present in only a small percentage of streams in these basins. Unfortunately, those streams that do possess this facility have a tremendous potential for reproducing the species.

Before the stream surveys reported herein, little was known of the characteristics of the majority of the streams flowing into Lake Superior or of their relative importance as present or future producers of sea lampreys.

The surveys of Lake Superior streams were instituted to determine the following:

1. The extent of sea lamprey penetration westerly in Lake Superior, as judged by actual observations of lampreys, spawning activities, and nests in the tributary streams (sea lampreys are now distributed throughout the lake).

- 2. The location and extent of potential spawning and larval habitats in the streams of the basin. Criteria used to determine the relative suitability of streams were established by Applegate (1950) and other workers; specific water temperatures, velocities, and bottom types necessary for successful completion of the stream phases of the life cycle were determined.
- 3. The best sites for control structures in streams which are apparently suitable or are actually used by sea lampreys for spawning.

During the summer of 1950, all of the streams from the Tahquamenon River (Chippewa County, Mich.) west to the tip of the Keweenaw Peninsula were examined (figs. 1-17). The personnel included, in addition to authors, Clifford Brynildson, Daniel Garn, William Gaylord, Carl Jacoby, Alberton McLain, and Phillip Parker. The 1951 survey was conducted by Howard Loeb, William Gaylord, Carl Jacoby, and George Simmons; this party examined streams in the area between the tip of the Keweenaw Peninsula and the Michigan-Wisconsin border (figs. 1, 18-23).

Appreciation is extended to the Institute for Fisheries Research, Michigan Department of Conservation, for data on the Two Hearted River, and to Leo F. Erkkila of the Fish and Wildlife Service for data on utilization by the lamprey of several streams (table 23. Alan C. Bennett prepared the maps, and William Gaylord identified lamprey larvae.

### Digest of principal findings

Results of the 1950 and 1951 stream surveys in the Lake Superior watershed are summarized as follows (figs. 2-17 and 18-23):

### Number of streams and tributaries examined:

- 1950: 869 (Tahquamenon River west to the tip of Keweenaw Peninsula)
- 1951: 178 (tip of Keweenaw Peninsula west to Michigan-Wisconsin border)

Of the streams examined in 1950, detailed data were obtained for 330. (Tables 1-16 present information on the 112 streams which possessed some potential for reproducing the sea lamprey.) The remaining 539 streams which appear on large-scale maps of the area were found to fall in one of the following categories:

- 1. Nonexistens.
- 2. Considered from preliminary examination as not suitable for the reproduction of sea lampreys.
- 3. Tributaries not in need of examination because extensive potential spawning habitat had already been found in the watershed.

Detailed data were collected for all of the 178 streams examined in 1951 (tables 17-22). The 1951 survey was less extensive than that of 1950 in that most of the minor tributaries of each watershed were not examined.

However, all of the 315 watersheds flowing directly into Lake Superior from the Tahquamenon west of the Michigan-Wisconsin border (1950 and 1951 survey areas) have now been examined in sufficient detail for the purposes of this survey.

Streams with a large productive potential (Space for more than 75 nests): 53

Streams with a medium productive potential (Space for 6 to 75 nests): 117
Streams with a small productive potential (Space for 1 to 5 nests): 75

The standards on which the above groupings are based are, of course, arbitrary and are intended only to provide a convenient system of classification. Productive potential is defined as the capacity of a stream to produce sea lampreys, expressed as the number of nests which may be constructed on the spawning sites available when:

- 1. Certain less variable factors such as quality of gravel (Spawning material), gradients, velocities, and stream sizes are believed to be satisfactory for reproduction.
- .2. Highly variable factors such as temperature and effects of freshets, which cannot be accurately evaluated (in most situations) on the basis of available information, are considered as favorable.
- 3. Survival of larvae from the nests may be anticipated to be normal.

Streams in which adult sea lampreys were observed or reported (see also table 23):

- 1950 survey area: 7 (Additional records available from 1951 rechecks will be presented in a later report.)
- 1951 survey area: none (Most of the streams were examined after the spawning season.)

Streams in which sea lamprey nests were observed or reported (see also table 23):

1950 survey area: 14 (Additional records available from rechecks made in 1951 will be presented in a later report).

1951 survey area: 1

It is probable that nests were present in other streams but were not observed because:

- 1. The general rarity of nests in the Lake Superior region would make it entirely possible to miss an occasional single nest.
- 2. The brown color of many streams may have obscured some nests.
- 3. Nests may have been destroyed in streams examined long after the spawning season.

### Streams in which sea-lamprey larvae were obtained (see also table 23):

- 1950 survey area: 1 (Almost all streams were examined for larvae; lamprey larvae of several species were obtained from 23 streams).
- 1951 survey area: none (No streams in this area were checked for larvae).

### Streams upon which some type of control may eventually be necessary:

1950 survey area: 112

1951 survey area: 136

Tributary streams in this group can be controlled by devices placed on main streams. The need for control on many of these streams can be determined only by future examination.

Stream mileages: Over 1,300 miles of stream were surveyed in 1950; the combined lengths of all streams in the area amount to considerably more than that. The lengths of all streams in the 1951 area aggregate over 1,500 miles, of which several hundred miles were surveyed.

### Scandards and methods

Criteria used in estimating the productive potentials of Lake Superior basin streams were established during a study of the life history of the sea lamprey by Applegate (1950).

The life history of the sea lamprey in the Great Lakes can be summarized as follows. In the spring the adults ascent streams and spawn on gravel. After a short period of incubation the eggs hatch and the larvae emerge. These larvae, carried downstream by the current, dive for and burrow into the bottom when quiet water is reached. Metamorphosis takes place after a larval life of about 4 years. The resulting sexually immature adults are carried by high water to the lakes where the parasitic life of 12 to 20 months begins.

For successful completion of the stream phases of the life cycle, certain known basic conditions among others must prevail in the streams. Suitable larval habitat consisting of soft (sand or silt) bottom material must be present in the streams proper or in their estuaries, In order to spawn, adult lampreys require (1) water temperatures of about 53° F. or above, (2) water velocities of 1 to 5 feet a second, and (3) the presence of suitable gravel formations (or other hard elements such as clam shells) for nest building (Applegate 1950). These factors were found to be of optimum quality in certain streams when (1) water temperatures were between 60° F. and 70° F.; (2) water velocities ranged from 1 to 3 feet a second; (3) stream-bed formations consisted of concentrated gravel of ideal size (3/4 inch to 3 inches in diameter) in bars or ridges which formed riffle areas. These criteria are based on studies of lampreys in streams flowing into Lakes Huron and Michigan. It is suspected that spawning may be inhibited in many Lake Superior streams by certain conditions which are common in that area, such as colder water temperatures, steep gradients, sudden freshets, and heavy turbidity due to lake clay.

The streams were examined by walking or canoeing along their courses for the distance required to determine their productive potentials; if abundant spawning habitat or an obvious barrier was found in a stream section just above the mouth, examination of that stream was discontinued; streams in which gravel was lacking were surveyed from mouths to headwaters to make certain of the lack.

Standardized methods and techniques were employed so far as it was practical to do so. The necessity for covering a large amount of territory demanded deviation from preferred methods (usually the employment of visual estimates instead of measurements) often enough to warrant an explanation of those actually used in this particular survey.

Stream lengths: Computed from county maps (Michigan Department of Conservation); a correction factor (variable) based on the estimated increase due to meandering, was applied to each computed length.

Stream widths: Average widths were computed from a series of measurements and visual estimates taken at varying distances apart; accurate measurements (steel tape) were made at potential control sites, and at most points where lampreys, nests, and suitable spawning habitat were located. At the beginning of the 1950 survey, the majority of widths were determined by direct measurement. As the season progressed and biologists became more experienced, most widths were determined by visual estimates checked frequently by tape measurements.

Stream depths: Depths were determined at the time widths were recorded.

Accurate depth measurements in shallow streams were made with a yardstick.

The average depth of a stream at any one point was calculated from measurements at the stream center and at points midway between the center and the edges. Individual depths in deep streams (often turbid) were obtained with a sounding line.

Water velocities: Velocities were determined at the time widths and depths were recorded. At the beginning of the survey, velocities at individual points were taken by the "chip" method (velocity in feet per second was calculated from the time required for a small glass vial half filled with water to float over a measured distance; an average was obtained from three measurements). As the survey progressed, velocities were determined by visual estimates, checked frequently by the chip method. The chip method was impracticable in many small streams because of obstructions.

Water temperatures: Taken with Taylor pocket thermometers to the nearest degree Fahrenheit.

Gradients: Determined by visual estimation, and classified as follows:

Slight: Stream bed appearing to be flat or with slight evidence of gradient.

Steep? Appearing to be approximately 10 or more.

Moderate: Between slight and steep.

Visual estimates were accurate enough for the purposes of this survey. Gradients were noted frequently.

Bottom types: The total amounts of each type were arrived at by visual estimates. Soft bottom was classified as sand, silt, mud, and clay. The presence of hardpan was also noted. Hard bottom was classified as bedrock, boulders (12 inches in diameter and up), rubble (3 inches to 12 inches in diameter), large gravel (3/4 inch to 3 inches in diameter), and small gravel (1/4 inch to 3/4 inch in diameter).

Spawning sites: Gravel deposits were classified as follows (in order of suitability):

### 1. Concentrated

- a. Gravel bars and ridges on riffles.
- b. Continuously flat, pavement-like formations in riffle areas.

### 2. Scattered

- a. Patches of large gravel.
- b. Discontinuous, variable amounts of gravel in or upon other substrata.
- c. Gravel mixed with rubble and boulders.

Possible number of nests: A visual estimate was made of the possible number of nests which could be constructed on the gravel formations present.

Barriers: Classified as natural or man-made. Great Lakes sea lampreys cannot ascent smooth perpendicular barriers which are 3 feet or more in height. Their ability to ascend broken and irregular rock formations is greater; they have been observed negotiating a falls 7 feet high, which had a face of irregularly eroded limestone.

Adult lampreys and nests: Locations and numbers of nests were recorded with accompanying notes on type of spawning material, quality of gravel formations, and other factors. The numbers of adult lampreys were recorded in relation to activity (swimming, resting, spawning), condition (unspawned, partially spawned, spent, dying, or dead), and location. Samples of lampreys were collected and preserved.

Larval lampreys: During the 1950 survey, almost all streams were examined at various distances below spawning habitat for larvae, which were collected from all types of habitat by digging. All larvae were preserved for identification. No attempt was made to collect larvae in 1951.

Color of streams: Classified as brown or colorless, by visual examination.

Turbidity of streams: Classified as clear, or slightly, moderately, or heavily turbid.

Water levels: Annual fluctuations were determined by noting high-water marks and condition of stream at time of examination. When possible, the characteristics of individual streams in relation to extent of precipitation were recorded. Special attention was paid to water-level conditions at proposed control sites.

Pollution: Sources of industrial and domestic pollution were noted (visually) and recorded.

General topography and geographical features: Stream banks, flood plains, and the surrounding country were described. General measurements such as heights, widths and contour were recorded. Soil and plant types were noted, although not in great detail. Road conditions, location of power lines, and relative accessibility of streams and proposed control sites were noted.

Location of control sites: Potential control sites were located in most streams which were found to have productive possibilities. Criteria for selecting control sites (for mechanical weirs; barrier dams, and electrical devices) were established during experimentation with various types of control devices (Applegate and Smith 1951). Flora and fauna: Only limited observations were made. Exceptional conditions (for example, extreme abundance of aquatic plants) were noted. A limited amount of seining for fish was done.

### Evaluation of streams

For the sake of convenience and simplicity, the entire Michigan watershed of Lake Superior has been divided into 22 areas (figs. 2-23; tables 1-22), each of which is discussed separately.

With each figure and table are brief comments on the area and its streams, factors which may inhibit or prevent spawning in the future, and control possibilities.

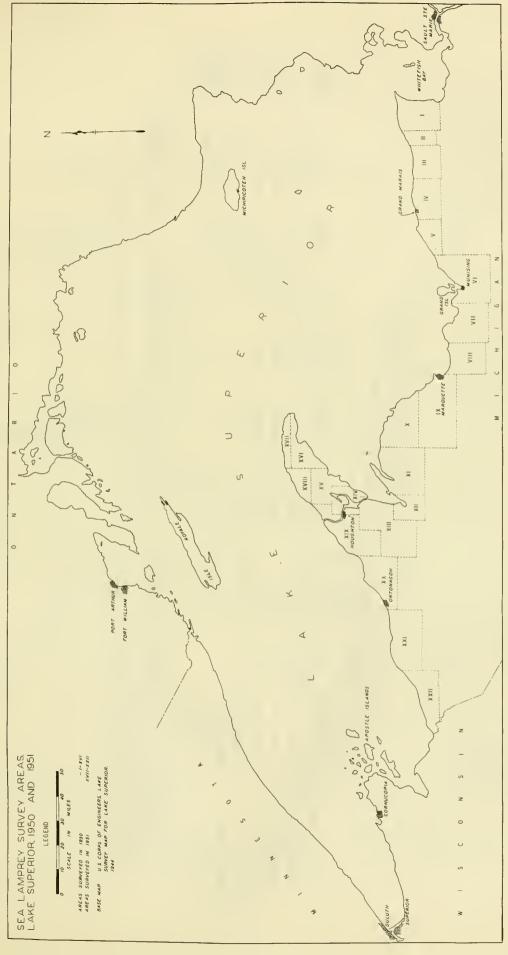


Figure 1.- Lake Superior, showing areas, and their arbitrary subdivisions, surveyed in 1950 and 1951.

Table 1. -- Productive potential, recommended control devices, and miscellaneous fectors concerning atraems in Area l (Survey made in 1950)

Type of control passible 4/	Electricel	Mechanical	Electrical	hechanical	Mechanical	Mechanical weir & trap	
Possible limiting factors	Spewning eites, velocity	Temperature	None	Shifting bottom	Shifting bottom	Shifting bottom	
Productive patential	Madium	Smell	Larga	Small	hadium	Smell	
Data	6/9-9/9	6/9-7/10	6/13-7/10	6/28	6/26	6/27-7/2	
Tampera- tures in dagress F.	29-68	52-68	55-71	63	65	56-68	
Ranga in valueity in ft./asc. 3/	Sluggish-5.0	Sluggiah-2.5	Sluggiab-3.0	1,25	2.0	1.25	
Range in gredient 3/	Slight-moderate	Slight-moderate	Slight	Slight	Slight	Slight	
Average depth of stream 3/	0.8	1.5	2.0	0.5	1.0	0.33	
Average Average width depth of atream stream in ft. 3/ in ft. 3/	300.0	4.0	25.0	0.9	10.0	5.0	
Length of stream in milea 2/	20.0	2.0	42.0	0.25	0.25	0.05	
County, tawnship line, rengs, and section no. at mouth	Chippewa, 48-6-14	Chippewa, 49-6-27	Chippewa, 49-6-2	Chippewa, 50-7-1	Chippewa, 50-7-2	Chippewa, 50-7-4	
Name of stream 1	Tabquemenon River	Obriens Creek	Betsy Mvar	Craek # 1	Vermilion Greek	Craek # 2	

"Langth" is the meseurament of that portion of the stream surveyed, and is composed of a calculation of map distance plus application of a correction factor (veriable) compiled from field measurements. The atream length figures differ from total langth in all cases where barriar dams or field conditions terminated the area usable by sea lamprays short of the headwaters. Liat includas only those streams which appear to have a productive potential or for which control devices have been recommended. ना ला

Applicable only to the surveyed partion of the stream.

From an enginaaring standpoint, elactrical control davicaa can probably be installed in all streams for which mechanical davices have been recommended. छ। का

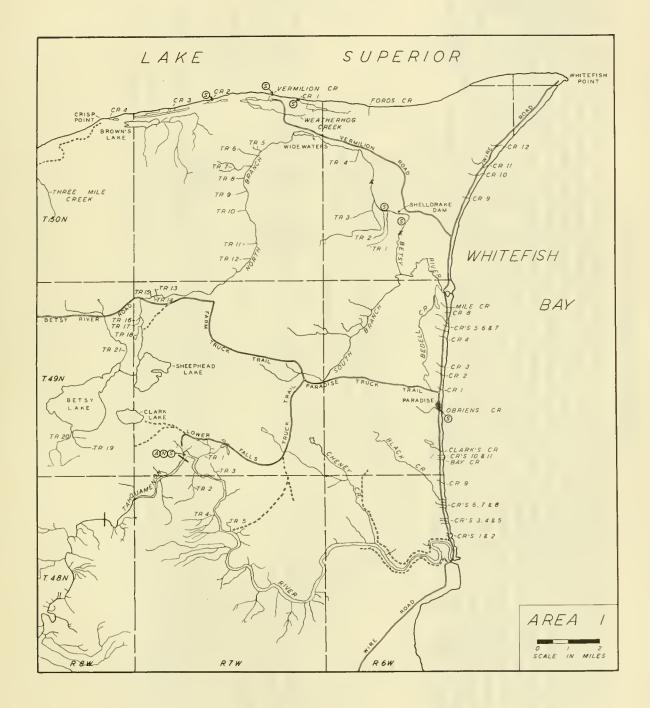


Figure 2.—Area 1.

### Description of Area 1 (Fig. 2)

numerous small coastal streams. Adult sea lampreys and nests were observed only in the Tahquamenon a greater extent in portions of the North Branch of the Betsy River. The Tahquamenon River is much it is much smaller, the Betsy River presents a similar problem. Creeks Nos. 1 and 2 are relatively and sandy-bottomed. Most of them drain extensive bogs and swamps, and flow through thick tag alder River just below the Lower Falls. Limited potential spawning habitat is present at that point and near the mouths of four small coastal streams (table 1). Potential spawning habitat is present to too large for mechanical control devices; an electrical control device is recommended. Although Embraces most of the western portion of Chippewa County, Mich., and contains a few large and inaccessible. All but a very few of the streams are brown in color, of relatively low velocity, flood plains. The soil, which is generally sandy and poor, supports a jackpine - white pine popple climax type. Topography is gentle.

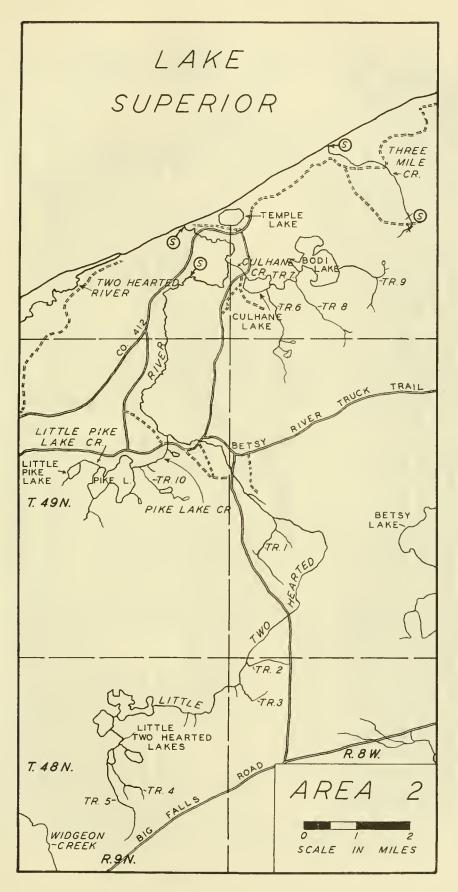
Table 2.--Productive potential, recommended control devices, and miscelleneous fectors concerning streams in Aree 2 (Survey made in 1950)

Type of control possible 4/	Mechenicel weir & trep	Electricel
Type contr poest	Meche y weir	Elect
Possible limiting factors	Spawning altee, tempereture, velocity	Spewning sites, shifting bottom, tempereture
Productive potential	Medium	Medium
Dete	7/2-7/3	7/4-1/8
Tempere- tures in degrees F.	50-54	53-76
Range in Tempere- velocity tures in in ft./sec. 3/ degrees F. Date	0.75-1.25	1.0-2.0
Length Averege Averege of width depth depth stream of reason of reason alone 2/ in ft. 3/ in ft. 3/ gredient 3/	Slight	Slight
Averege depth of stream in ft. 3/	99.0	2,0
Averege width of etreem 3/	8.0	20.0
Length of stream in miles 2/	5.0	32.0
County, township line, reage, end section no. et mouth	Luce, 50-8-16	Luce, 50-9-24
Neme of stream 1/	Three Mile Creek	Little Two Heerted R.

Last includes only those etresms which appear to have a productive potential or for which control devices have been recommended. ने ले

<sup>&</sup>quot;Longth" is the mecaurement of that portion of the atream surveyed, and is composed of a celculation of map distance plus application of a correction fector (variable) compiled mecaurements. The stream length figures differ from total langth in all ceses where field conditions termineted the eree useble by see lampraye abort of the heafesters.

Applicable only to the surveyed portion of the streem. From an engineering stendpoint, electrical control devicee can probebly be installed in ell streems for which mechenical devices heve heen recommended. लो को



# Description of Area 2 (Fig. 3)

climax type is predominantly coniferous. The topography is low and accordingly much of the area erally brown in color, of relatively low velocity, and sandy-bottomed; they flow through flood plains covered with a dense growth of tag alder. The soil is sandy and poor, and the forest Embraces a portion of eastern Luce County, Mich., and contains only two streams and their mechanical control, and an electrical device is recommended. The streams in the area are gentributaries. No adult sea lampreys or nests were observed, but both main streams contained potential spawning habitat. The Little Two Hearted River is probably too large for practical consists of bogs and swamps.

Table 3. -- Productive potentiel, recommended control devices, and miecelleneous fectore concerning etreame in Aree 3 (Survey mede to 1950)

Type of control possible 4/	Electricel	/9	2/	/5	્રે	Electricel
Possible limiting factors	Temperature	Tempereture	Tempereture	Temperature	Tempera ture	Velocity
Productive potentiel	Large	Lerge	Large	Large	Medium	Med1um
Date	7/11-1/13	7/11-7/22	7/13-7/31	7/25-7/26	7/28-8/3	8/5
Tempere- tures in degrees F.	53-68	51-72	53-65	56-61	57-65	56-65
Range in velocity in ft./eec. 3/	1.0-3.0	Sluggieh-3.0	1.3	Sluggleh-2.25	Sluggieh-1.0	Sluggish-2.5
Range in g/gredient 3/	Slight	Slight	Slight-moderate	Slight-moderate	Slight	Slight
Averege deptb of otreem 3/	4.0	1.5	3.0 8	1.0 S	99*0	1.0
Averege width of stream 3/	50.0	25.0	30.0	15.0	10.0	20.0
length of etreem in miles 2/	10.0	25.0	50.0	20.0	30.0	8.0
Coupty, townehip libe, renge, end section no, et mouth	Luce, 50-9-27	Luce, 50-10-1	Luce, 49-9-6	Luce, 49-10-29	Luce, 48-11-1	Luce, 50-11-34
Name of atreem 1/ s	Two Heerted River	E. Br. Two Hearted R. D.	W. Br. Two Reerted R. L.	Dewson Creek	N. Br. Two Hearted R. L	Deed Sucker River L

List includes only those streams which appear to have a productive potential or for which control devices have been recommended.

<sup>&</sup>quot;length" is the messurement of thet portion of the etreem surveyed, and is composed of a celulation of machine of a correction factor (varieble) compiled from field messurements. The etreem length figures differ from total langth in all cases where field conditions terminated the erea usable by sea lampraye ना ला

Applicable only to the surveyed portion of the etream.

From an engineering atandpoint, electrical control devices can probably be installed in all atreams for which mechanical devices beve been recommended. Stream tributery to enother upon which it would be more practicel to place a control device. ह्य का छा

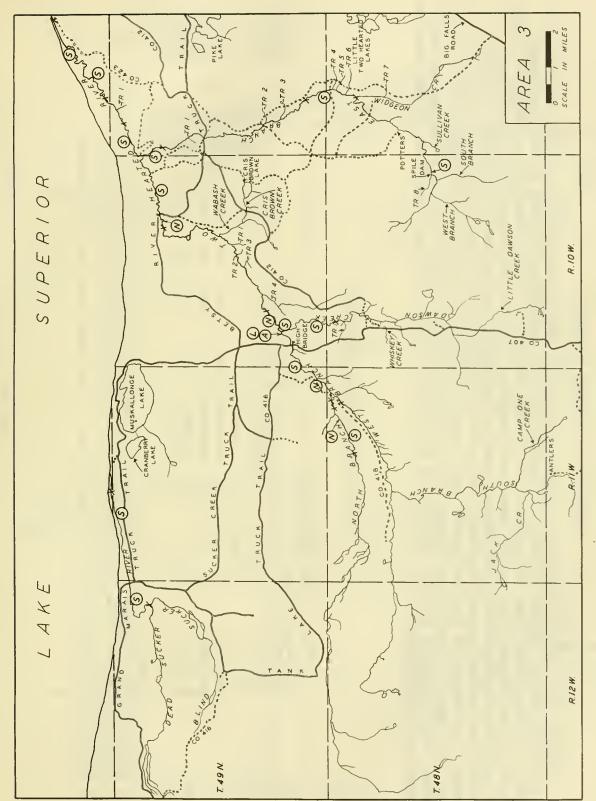


Figure 4.--Area 3.

# Description of Area 3 (Fig. 4)

swamps. The streams of the Two Hearted River system are brown in color and of moderate water velocity; River. Unlimited facilities for spawning are present throughout much of the Two Hearted River system; Embraces the northern portion of western Luce County, Mich., and contains only two streams, both of which are large. Limited amounts of potential spawning habitat are present in the Dead Sucker swamps. The topography is low. The soil is sandy and poor and accordingly the forest climax type is several adults, larvae, and over 60 nests were observed in 1950 in this watershed. Both streams are too large for practical mechanical control devices; electrical devices are recommended. The Dead they flow through flood plains covered with dense stands of tag alder and drain extensive bogs and Sucker River is clear and of relatively low velocity; it drains an extensive low area of bogs and predominantly coniferous.

Table 4.--Productive potentie), recommended control devices, and miscellaceous fectors concenting etreams in Ares 4 (Survey made in 1950)

Name of stream $1/$	County line, section	County, townehip line, renge, and section no. at mouth	Length of stream in les 2/	Length Averege Average of with depth stream of the stream of the stream etream miles 2/ in ft. 3/ in ft. 3/	Average depth of etream in ft. 3/	Range in gradient 3/	Ranga in valocity io ft./eec. 3/	Tempera- turae 1o degrace F. Date	Date	Productive potential	Possible limiting factors	Type of control possible 4/
Sucker Edver	Alger,	Alger, 49-13-4	30.0	25.0	1.0	Slight-moderate 1.0-5.0	1.0-5.0	52-65	8/7-8/18	Large	Velecity,	Electrical
											temperatura	
Baker Creek	Algar,	Algar, 49-13-4	7.0	10.0	0.66	Slight	0.75-1.0	;	;	Small	Spawning eites,	Machanicel
											temperatura	welr & trap
Creek # 1	Alger,	Alger, 49-13-5	0.3	1.5	0.12	Slight-moderate	1.0-2.0	59-67	8/8	Small	Temperetura,	Mechanical
											gradients	weir & trep
Craek # 3	Alger,	alger, 49-13-6	0.75	5.0	0,16	Slight-moderate	1.0	57-60	8/8	Small	Tempare ture,	Mechanical
											gradiente	weir & trap
Creek # 4	Alger,	Alger, 49-13-6	0.3	1.0	80.0	Slight-moderate	0.5	55	6/8	Small	Width, depth,	Mechanical
											temperatura	weir & trap
Sable Creek	Alger,	Alger, 49-14-2	0.5	15.0	1.0	Slight-moderate 1.25-2.0	1,25-2,0	64	6/8	Medium	Spawning sitee,	Electrical
											velocity,	
											temperature	

<sup>&</sup>quot;Length" is the messurement of that portion of the stream surveyed, and is composed of a calculation of map distance plus application of a correction feator (variable) compiled from final messurements. The stream length figures differ from total length in all cases where field conditions terminated the erea usable by sea lampreys abort of the headwarkers. Liet includes only those atreems which appear to have a productiva potantial or for which control devices have been racommended.

<sup>/</sup> Applicable only to the surveyed portion of the stream.

From an segimeering standpoint, electrical control devices can probably be installed in all streams for which machanical devices have beso recommended.

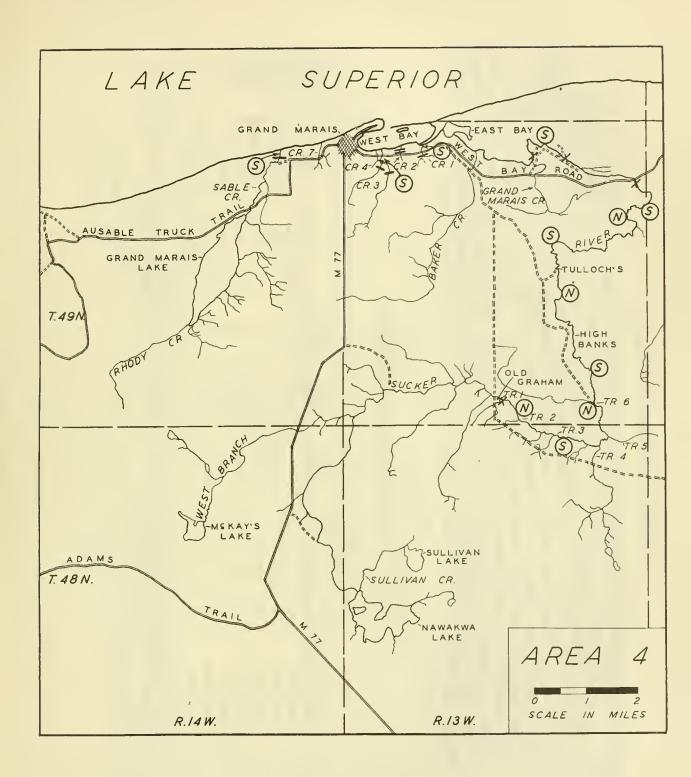


Figure 5.—Area 4.

### Description of Area 4 (Fig. 5)

of West Bay and the mouth of Sable Creek. The soil is sandy and poor, and accordingly the forest Creeks Nos. 1, 3, and 4, and Sable Creek. The Sucker River is too large for a practical mechania rule, gentle; an exception is the steep snoreline of former glacial Lake Nipissing, just south cal control device; an electrical device is recommended. Mechanical control devices can be conflood plains covered with heavy stands of tag alder, hardwoods and cedar. The topography is, as Embraces the northeast portion of Alger County, Mich., and contains six streams which are structed in the remaining streams, but fluctuations in water volumes may be a problem. The streams in the area are generally brown in color and of moderate velocity; they flow through accessible to the sea lamprey. Sea lamprey nests were observed in the Sucker River in 1950. Extensive spawning habitat is present in that river and to a limited extent in Baker Creek, climax type is predominantly confferous. Much of the area is cut and burned over.

Tabla 5.--Productive potential, recommended control devices, and miscellaneous fectors concerning streams in Area 5 (Survey made in 1950)

	Type of control possible 4/	Mechanical	Mechenical Weir & trap	Mechenicel weir & trap	्रो	্য	্য	2
	Posaible liniting fectore	Valocity, gradiant,	Temperature	Tampareture	Temparature	Temperatura	Gradiant, valocity,	Temperatura
	Productive potentiel	Larga	Medium	Large	Madium	Medium	Medium	Sme 11
1	Date	1	;	ì	9/10	9/10	9/4	9/10
	Tempers- tures in degrees F.	í h l	-	1	20	56	54	49-55
	Range in valocity in ft./sec. 3/	1.0-5.0	1.0-4.0	Sluggiah-3.0	Sluggiab-1.0	1.25	1.0-2.0	0.75-1.0
	Range in 3/ gredient 3/	Slight-steep	Slight-moderate	Slight-moderate	Slight-moderate	Slight	Slight-ateep	Slight-moderate
	Avarege depth of atream 3/	1.0	0.58	1.0	1.0	0.5	0.25	0.5
	Average Avarage width depth of of etraem 3/ in ft. 3/ in ft. 3/	20.0	5.0	20.0	15.0	0.9	0.0	4.0
	Length of streem in miles 2/	12.0	0.8	10.0	3.0	4.0	3.5	3.5
	County, township line, range, end section no. et mouth	Algar, 49-15-3	Algar, 49-15-9	Alger, 49-16-25	Alger, 49-16-17	Alger, 48-16-17	Alger, 48-16-13	Alger, 48-17-13
	Name of atream 1/	Hurricana Creek	Sulliven Greek	Seven Mile Crsek	Lownay Craak	Tributary # 7	Tributery # 6	Tributary # 5

List includae only those etreams which eppear to heve e productive potentiel or for which control devices heve been recommended.

<sup>\*</sup>Length\* is the messurement of thet portion of the stream surveyed, end is composed of a celculation of map distance plus application of a correction fector (variable) compiled from field messurements. The stream length figures differ from total length in all cases where field conditions terminated the eres usoble by sas lamprays

Applicable only to the aurveyed portion of the streem.

From en engineering standpoint, electrical control devices cen probebly be installed in all streams for which mechanical devices heve been recommended. ल के ज

Stream tributery to another upon which it would be more practical to place a control device.

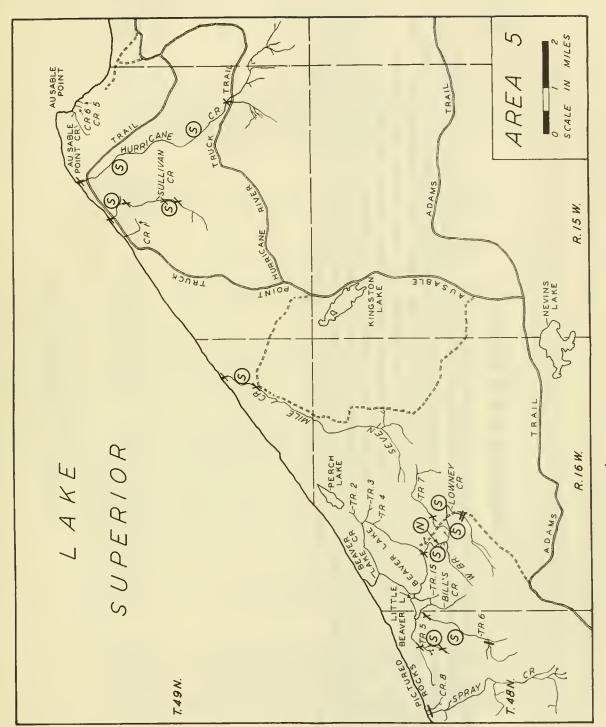


Figure 6.-Area 5.

### Description of Area 5 (Fig. 6)

is relatively inaccessible. Migrations to the streams of the Beaver Jake watershed can be constreams in which spawning facilities are accessible to upstream migrants (table 5). Mechanical Beaver Lake Greek is interesting in that it forms an exact line of demarcation between the low, (often overlying bedrock) which is predominant to the west. Gradients are steep and velocities The latter trolled by a device in Beaver Lake Greek; most of the streams in this system are relatively sandy country extending east to the Tahquamenon River and the more rugged sandy-loam country Embraces the north-central portion of Alger County, Mich., and contains at least seven inaccessible. Stream gradients are slight to steep and water velocities vary accordingly. are higher in many of the western streams. Hardwoods are predominant on the better soils control devices can be constructed in Hurricane, Sullivan, and Seven Mile Greeks.

Table 6.--Productive potential, recommended control devices, end miscelleneoue factors concerning streems in Aree 6 (Survey made in 1950)

	Type of	control possible 4/	Machenicel	weir & trap	2	্য	Mechanicel	weir & trap 5/	ग	Wechanical weir & trap	Wechanical	Weir & trap	weir & trap	Mechanical	weir & trap	weir & trun	Mechanical	weir & trap	Mechanical	Well & trap		/ু	Electrical	2/	গ ়	ો	িত্	Mechanical	Mechanical weir & trap
		Possible limiting fectors	Scouring et mouth,	pertiel berrier,	Gredient, velocity,	tempereture Gredient, velocity,	tempereture Velocity,	tempereture	tempereture	Tempereture	Gredient, velocity,	tempereture Gredient welcoity	tempereture	Grediect, velocity,	tempereture	termorphine	Gradient, velocity,	tempereture	Gredient, velocity,	temperature		Gradient, velocity,	Tempereture,	Temperature	velocity	Gradient, velocity,	Tempere ture	Tempereture	Temperature, dry etreem bed
		Productive potentiel	Medium		Small	Medium	Large	[] ame		Large	Small	Cmo 11	TTOTAL	Small		TT BULL	Small		Spna 11	Modt um	Thou a	Medium	Large	Mod 6 11m	me a main	Medium	Small	Smell	Small
		Date	9/11		ì	9/14	9/14	4/1/8	44/6	8/4-8/8	8/16-9/18	0/16	01/6	9/16		8/10-8/18	9/16-9/18		9/16-9/18	96/0-81/0	0~/6~07/6	9/16	9/18	02/0-06/0	00/8-02/8	9/20	9/20	61/6	9/18
	Tempera-	tures in degrees F.	58		1	48-50	53		3	20-60	46-50	ų,	P	48	į	Tc	46-50		46-48	78.50		20	54	, L	70-10	50-53	48-49	51	53
	Pange in	velocity in ft./sec. 3/	Slugg1sh-1.0		1.0-3.0	Sluggish-3.0	1.0-3.0	0.8-0.1		0.75-1.25	0.75-1.25	0 75-1 26	0.0-1-0.00	0.75-1.25	;	Singgien-0.75	0,75-1,25		0.75-1.25	0 26.30	0.00	1.0-3.0	Sluggish-3.0	0 6 96 0	0.73-67.0	Sluggish-2.0	0.75-1.0	Sluggieb	Sluggieh-0.75
		Range in 3/	Slight-moderete		Slight-steep	Slight-steep	Slight-steep	014 ph + + + + + + + + + + + + + + + + + +		Slight-moderete	Slight-steep	4 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	daane name	Slight-steep		Slight-moderate	Slight-steep	,	Slight-steep	440710	STIER	Slight-steep	Slight-moderate	oliche eleen	ZIIEur-ereep	Slight-steep	}	Slight	Slight
Averege	depth of	stream in ft. $3/$	2.0		0.33	0.33	0.5	01		0.5	0.08		0000	0.08		0.33	0,16		0.25	6	0	0.25	1.0	u	0.0	0.5	0.04	0.25	0.33
Average	width of	stream 3/	18.0		20.0	4.0	15.0	ď		15.0	2.0	c	0.9	2.0		4.0	2.0		3.0	0	70.0	10.0	12.0	C	0.0	10.0	2.0	2.0	4.0
Length	ofetream	in miles 2/	1.0		0.25	2.0	3.0	200	3	4.0	0.75	u c	0.50	0.25		0.5	0.5		0.25	0	10.01	0.3	0.75		4°	6.0	0.3	2.0	0.75
	County, township	line, renge, end section no. et mouth	alger, 48-17-21		Alger, 48-17-28	Alger, 48-17-29	Alger, 48-18-25	19-18-18	44864, 10-10-11	Alger, 47-18-3	Alger, 47-18-30	25 01 07	Alger, 47-18-30	Alger, 47-19-36		Alger, 47-19-36	Alger, 46-19-1		Alger, 46-19-1	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Alger, to-19-6	Alger, 46-19-11	Alger, 47-19-29	00 00 00 00 00 00	ALGEL, 47-18-28	Alger, 47-19-29	Alger, 47-20-25	Alger, 47-19-19	Alger, 47-19-18
		Name of etream 1/	Chapel lake Creek		Tributery # 13	Tributary # 16	Mosquito River	That has to me to the	" # figaratit	Miners River	Creek # 22	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	Creek # 43	Creek # 24		Creek # 25	Creek # 26		Creek # 27	200	And M.ver	Wegner Greek	Furnace Creek		congeeu creek	Hanson Creek	Tributery # 5	Creek # 6	Greek # 7

List includes only those etreams which appear to heve a productive potential or for which control devices have been recommended.

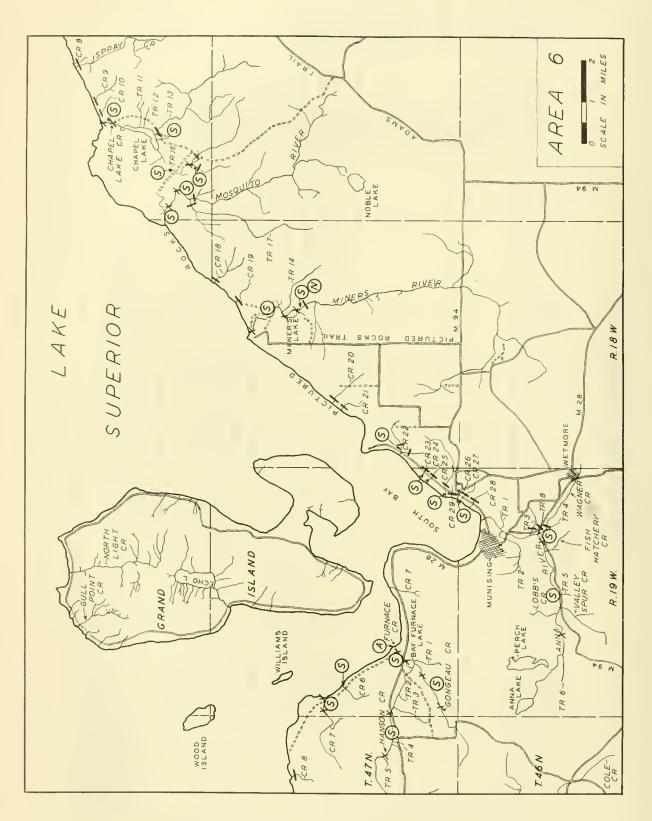
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<sup>&</sup>quot;Length" is the measurement of thet portion of the stream eurveyed, and is composed of a calculation of map distance plue application of a correction fector (verieble) compiled from field measurements. The stream length figures differ from total length in all ceses where field conditions terminated the area lamprays short of the headwaters.

Applicable only to the surveyed portion of the atream.

From an eugineering stendpoint, electrical central devices can probably be installed in all streams for which mechanical devices here accumended.

Stream tributary to another upon which it would be more practical to place a control device. ন ল



### Description of Area 6 (Fig. 7)

streams are irregular due to the presence of rubble, boulders, and bedrock. The topography of the area is relatively rugged. The sandy-loam soil overlies a bedrock substratum. Hardwoods Embraces a portion of northwestern Alger County, Mich., and contains at least one stream which was utilized by sea lampreys in 1950. Nests were observed in Miner's River; dead adults a mechanical weir is recommended for Miner's River and an electrical device for Furnace Creek. gradients range from slight to steep and velocities wary accordingly. The bottoms of several Both streams have a large productive potential; Fifteen other streams contain spawning facilities. Chapel Lake Creek and the Mosquito River predominant. Grant Island which lies off the shore of Area 6 has not been examined. The streams of the area are both clear and brown in color; were observed at the mouth of Furnace Creek. are relatively inaccessible.

Table 7.--Productive potential, recommended control devices, and miscallaneous factors concerning streems to Aree 7 (Survey made in 1950)

Length
of of
a 2/ 10 ft. 3/
0.1 5.0 0.25
10.0 100.0 3.0
6.0 6.0 0.5
9.0 7.0 0.5
4.0 l2.0 0.5 Slight-moderate
7 5.0 0.33
3.0 10.0 0.33
6.0 25.0 Varies
22.0 20.0 0.66 Slight-moderate
6.0 4.0 0.25
3.0 3.0 0.5 Slight-moderate
6.0 4.0 0.25 Slight-moderata
10.0 8.0 0.5 Slight-moderate
1.0 15.0 0.5 Slight-eteep
1.5 15.0 0.5 Moderate-steep
30.0 20.0 1.0 Slight-moderate

List includes only those streams which appear to have a productive potential or for which control devices have been recommended.

"Length" is the measurement of that portion of the etream surveyed, and is composed of a calculation of map distance plus application of a correction factor.

"Length" is the measurements. The stream length figures differ from total length in all cases where field conditions to minated the erea useble by see lampreys short of the beadwaters.

Applicable only to the surveyed portion of the stream.

From an engineering attacholot, aboutical control devices can probably be installed in all streams for which mechanical devices have been recommended.

Stream attibutery to another upon which it would be more practical to place a control device. नोला

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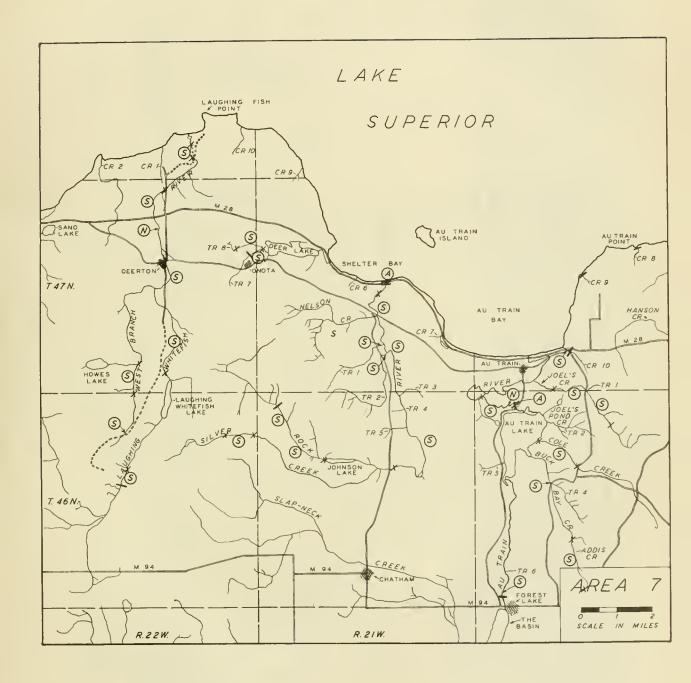


Figure 8.—Area 7.

### Description of Area 7 (Fig. 8)

Rock River. These three rivers are too large for practical mechanical control; electrical devices devices (mechanical) need be placed only in Creek No. 10 and Deer Lake Creek. The streams of the Embraces part of the northwestern portion of Alger County, Mich., and contains at least two Laughing Whitefish Rivers. Adult sea lampreys were seen in the Au Train and at the mouth of the area are both clear and brown in color and gradients range from slight to steep. The bottoms of are recommended. Spawning facilities are present in 13 other streams, but, at present, control several streams are irregular due to the presence of rubble, boulders, and bedrock. The typography of the area is relatively rugged. The sandy-loam soil overlies a bedrock substratum. streams which were utilized by sea lampreys in 1950. Nests were observed in the Au Train and Hardwoods predominate.

Table 8.--Froductive potential, recommended control devices, and miscellaneous fretors concerning atreams in Area 8 (Survey made in 1950)

Type of control g/	Electrical	/5	Electrical	\sigma	/ऽ
Possible limiting factors	Temperature,	Temperature,	Level fluc.,	temperature; Temperature, level fluc.	Obstacles, temperature
Productive potential	Medium	Stall	Large	Medium	Sme 11
Dete	10/7/50	10/1/20	6/6-9/25/50	9/14,15/50	8/24/50
Tempera- tures in degrees F. Dete	52	52	44-67	51-52	54-56
Fange in velocity in ft. 8ec. 3/	0.25-1.75	1.75	1.0-2.5	1,5	1.5-2.25
Range in gradient 3/	Slight	Slight	Slight	Moderate	Slight-steep
Average depth of atream 3/	1.0	0.33	1.0	в. О	6.0
length Average Average of stream of a stream of a stream at stream at a stream and in ft. 3/ in ft. 3/	33.0	0.0	46.0	22.5	20.0
Length of stream in miles 2/	20.0	9.25	23.0	3.3	4 • 0
County, township line, range, and section no. at mouth	Algar, 47-22-6	Marquette, 47-23-35	b.arquette, 47-24-6	Marquette, 46-24-14	Warquette, 46-24-14
Name of stream 1/	Sand River	E. Br. Sand River	Chocolay River	E. Br. Chocolay River	W. Br. Chocolay River

List includes only those streams which appear to bave a productive potential or for which control devices have been recommended.
"Length" is the messurement or that portion of the stream surveyed, and is composed of ecaluation or map distance plus application of a corrective factor (variable) compiled from this measurements. The stream length figures differ from total length in all cases where field conditions terminated the area usable by sea lamproys নাতা

Applicable only to the surveyed portion of the atrear.

The atreas are an expension, electrical courted devices can probably be installed in all streams for which machanical devices have been recommended.

Skream tributary to another upon which it would be more practical to place a control device. श्रिकाल

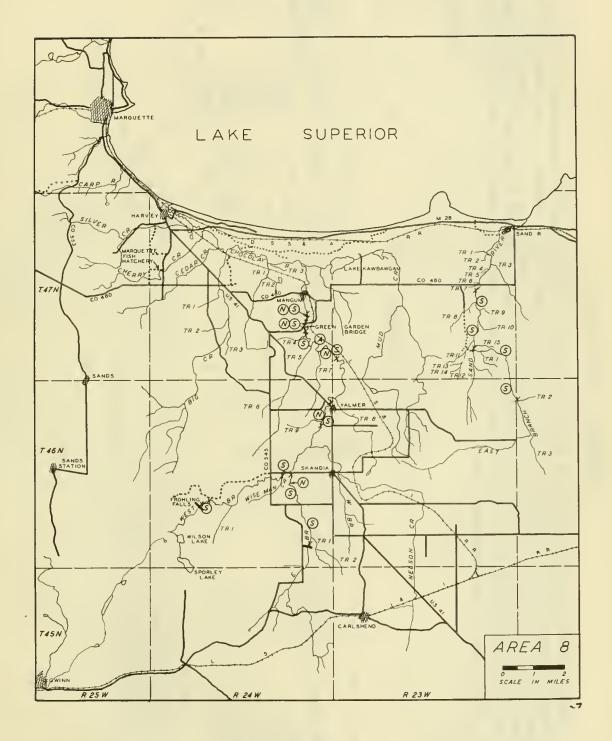


Figure 9.—Area 8

## Description of Area 8 (Fig. 9)

recommended. The streams of the area are brown in color and gradients range from slight to steep. Embraces the northeast portion of Marquette County, Michigan, and the watersheds of the Sand and Chocolay Rivers. Nests and adults were observed in considerable numbers in the Chocolay; both The area is characterized by rolling to rugged topography, sandy to gravely moraines, fairly rich streams contain appreciable amounts of spawning facilities. Control by electrical devices is soils, and mixed northern hardwood forest.

Table 9.--Productive potentiel, recommended control devices, and miscelleneous factors concerning streems in Aree 9 (Survey made in 1990)

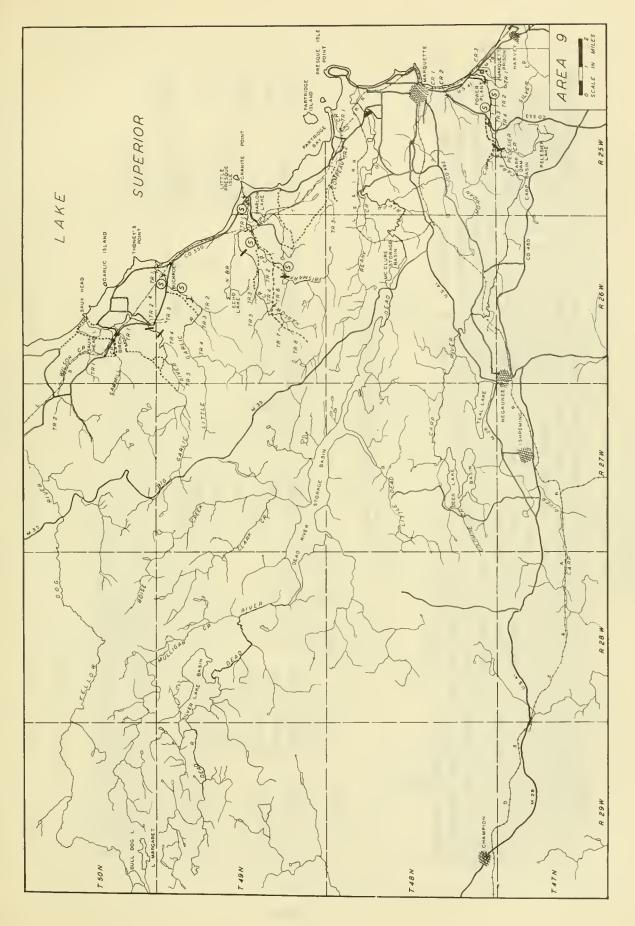
Name of stream $^{1}$	County, township line, reage, end section so, at mouth	nebip , end at mouth	Length of stream in miles 2/	Average Average width depth of of etream stream in ft. 3/ in ft. 3/		Range in 3/	Fage in Temperevelocity tures in in ft./sec. 3/ degrees F.	Tempere- tures in degreee F.	Date	Productive potential	Possible limiting fectors	Type of control possible 4/
	Marquette, 48-25-36	48-25-36	10.0	37.5	a • 0	Slight-steep	0.5-2.5	44-45	10/5	Medium	Level fluc., tempereture, pollutiom	Electrical
Harlow Greek	Marquette, 49-25-20	49-25-20	13.0	15.0	0.5	Slight-moderate Up to 1.0	Up to 1.0	57	9/30	Smell	Spawning sites, velocity, obstacles	Mechanicel weir & trep
Bismark Creek	Marquette, 49-26-24	49-26-24	8.5	15.0	0.5	Slight-steep	, s 2 2 3	58	10/1	Medium	Spawaing sitee, obetecles	امر
Little Carlic River	Marquette, 49-26-2	49-26-2	8.0	17.5	0.5	Slight-steep	1.0-1.75	55-57	9/30	Medium	Spawning eites	Mechanical weir & trep
Big Garlic River	Marquette, 50-26-21	50-26-21	13.0	20.0	0.75	Slight	0.9-1.5	වූ	10/2	None	Spewning ma- teriels, barrier falls	Mechenical weir & trap

List includes only those etreems which appear to have a productive potential or for which control devices have been recommended.

"Langh" is the measurement of that portion of the streem surveyed, and is composed of esclutation of may distance plus an application of a currective factor (variable) that is the measuremente. The streem langht figures differ from total langth in all cease where field conditions terminated the area usable by see lampreys

short of the heedweters.

Applicable only to the surveyed portion of the stream. From the stream of the stream of the machenical devices have been recommended. Stream engineering standarderized courted devices can probably be installed in all atreams for which it would be more practical to place a control device. ভাৰাতা



# Description of Area 9 (Fig. 10)

bottom constituents in many forms are abundant. Rugged, rocky hill and moraine topography predominates except in the narrow coastal sand plain; soils are light to heavy sandy loams over bedrock. control devices are recommended for the Carp and Big Garlic, and mechanical structures for the other potentially productive streams. The streams in the area are generally clear and brown (the Carp tends to be turbid and polluted in the lower reaches). Gradients range from slight to steep. Hard Embraces the north central portion of Marquette County, Mich., and includes the Carp, Dead, Big tributary to Lake Superior. All of these streams except the Dead River, with a barrier near its mouth, are potential lamprey producers but no evidence of utilization was observed. Electrical Garlic, and Little Garlic Rivers, Harlow and Compeau Creeks, and several small coastal streams Northern hardwoods are predominant.

Table 10.--Productive potentiel, recommended costrol devices, and miscellassous factore concerning etreams in Ares 10 (Survey made in 1990)

Neme of stream 1/	County, township line, renge, and section no. at mouth	Length of etream in miles 2/	Length Averaga Average of the fitter of the first of the first of the fitter of the fi	Average depth of atream 3/	Range in 3/	Range in valocity in ft./sac. 3/	Tampare- tures in degreae R.	Date	Productive potentiel	Possible limiting	Typa of control 4/
Iron Raer	Marquetta, 51-26-18	3.0	0.09	1,5	Slight	1.5	09	9/28/50	Small	Spawoing sites	Electrical
Selmon Trout River	Marquetta, 52-27-32	12.0	31.0	1.0	Slight-steep	1.0-2.5	51-54	9/27,28/50 Medium	Nedium	Temperature	Lechanical
Fine River	Warquette, 52-28-21	3.0	30.0	1.5	Slight	1.0-2.0	56	9/27/50	Wed1um	Spawning eitee,	Electrical
Rueh Creek	Marquette, 52-28-20	1.0	7.0	0.25	Slight	Up to 1.0	58	9/26/50	Small	velocity Obstacles, velocity	2
Mountair Stream	Marquette, 52-28-29	1.6	10.5	0.5	Moderete-steap	N	57	9/26/50	Medium	Obetaclae,	<u>اه</u>
Little Buron Rager	Marquette, 52-29-17	7.0	0.6	0.5	Slight-moderate 1.5-1.75	1.5-1.75	43-44	9/24/50	Medium	Spawning eitee, temperature, obstecles Mechanicel	Mechanical

List includes only those etreams which appear to have a productive potential or for which control devices have been recommended.

"Length" is the measurement of that portion of the stream surveyed, and is composed of a calculation of map distance plus application of a corrective fector (variabla) complied from find measurements. The stream langth figures differ from total langth in all cases where field conditions terminated the area usable by see lamprays short of the headwaters.

Applicable only to the surveyed portion of the streem. From an engineering standpoint, electrical control devices can probably be installed in all streems for which mechanical devices here been recommended. Streem tributery to enother upon which it would be more practical to place a control device.

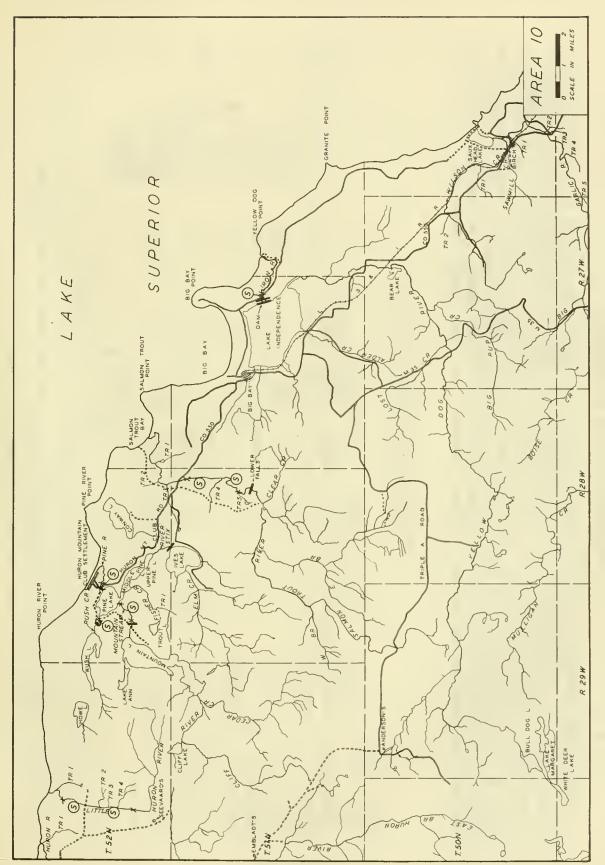


Figure 11.--Area 10.

## Description of Area 10 (Fig. 11)

and Little Huron. Clear, organically brown streams typify the area. Gradients range from slight to for the Yellow Dog-Iron system and the Pine; mechanical structures are suitable for the Salmon Trout mountainous wilderness characterizes the area. Morainic slopes and ridges occur commonly; soils are Embraces the northwestern portion of Marquette County, Mich., and contains the Yellow Dog-Iron, Salmon Trout, Pine, and Little Huron River watersheds. All have recognizable productive potentials Electrical control devices are recommended steep. Hard-bottom materials are common but soft constituents occur frequently. Rugged, rocky relatively rich, and overlay bedrock. Northern hardwoods and mixed growth predominate. but no evidence of past or present utilization exists.

Table 11. i-Froductive potentiel, recommended cootrol devices, end miscellaneous fectors concerning streems in Aree 11. (Survey made 10.1850)

Hame of streem 1/	County, township line, renge, and section no. et mouth	Length of etreem in miles 2/	Averege width of stream 3/	Averege depth of etreem 3/	Range in gradient 3/	Range in velocity in ft./sec. 3/	Tempera- tures in degrees F.	De¢e	Froductive potential	Possible limiting fectors	Type of control possible 4/
Huron River	harquette, 52-29-18	12.0	31.5	1.0	Slight-steep	1.5-1.75	48-51	9/23	Medium	Tempereture, level fluctuations, obstacles	Electrical
E. Br. Huron River	Barege, 52-30-35	4.75	25.0	0,33	l'oderate-steep	20.0	8	9/21	Nedium	Temperature, level fluctuetioss, obstecles	\s_
Trib. # 1 to E. Br. Huron River	Barege, 51-30-1	83 83	10.0	0.33	Slight-moderete	1.75	48	9/21	Smell	Temperature, spewming sites	्रि
W. Br. Huron Ruer	Barege, 52-30-35	2,0	12.0	0.66	A.oderete	0.0	1	1 1	Nedium	Level fluctuations, temperature, obstecles	⁄্র
Ravine River	Baregs, 51-31-4	10.0	21,5	0.5	Moderate-steep	0,75-2,0	62	8/31	Large	Level fluctuations	Mechenical
N. Br. Ravice River	Barege, 51-31-2	6.75	0.0	0.75	Moderete-steep	2.0- 7	9 8 1	:	Small	Spawning sites, level fluctuetions, tempereture, obstecles	/5
Slate River	Вегеда, 51-31-8	1.0	15.0	0.5	Slight-steep	0.5-1.75	59-63	8/31 & 9/12	Medium	Spawning eites, level fluctuetions, herriers	Electricel
Sliver River	Baregs, 51-31-18	13.0	45°C	0.0	Moderste-steep	1.0-1.75	54	8/31	Medium	Spawing sites, fluctuations, temperature, obstecles	Electricel

list includes ooly those streams which appear to have a productive potential or for which control devices have been recommended.
"Length" is the measurement of that portion of the stream eurreyed, and is composed of a calculation of map distance plus application of a corrective factor (veriable) compiled from field measurements. The stream length figures differ from total length to ell cases where field conditions terminated the eres usable by see lampreys short of the

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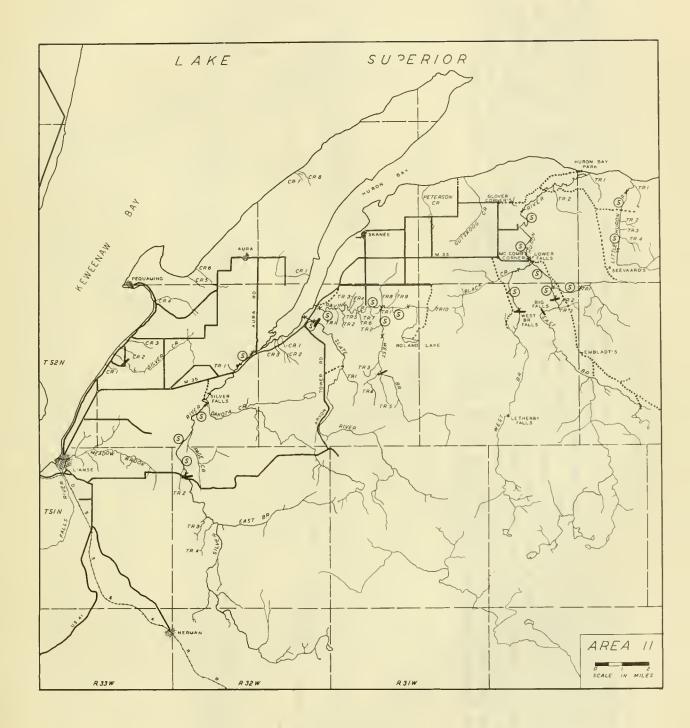


Figure 12.--Area 11.

## Description of Area 11 (Fig. 12)

and their tributaries are potential sea lamprey producers, and in several of them rather questionable clated rocky terrain typifies much of the area, particularly in the east, but old lake sands and wet Ravine, Slate, and Silver River watersheds, and several small coastal streams. All of these streams Slate, and Silver Rivers, and a mechanical structure for the Ravine. The streams of the area are brown in color. Gradients range from slight to steep, and surface velocities vary accordingly. Hard-bottom components of frequently inferior character (as spawning material) are common. Gla-Embraces a section of the northern portion of Baraga County, Mich., and contains the Huron, evidence of utilization was observed. Electrical control devices are recommended for the Huron, lowlands are more common to the west and along the Superior shore. Mixed growth composed of dominant hardwoods and some scrub popple forms the forest cover.

Table 12.--Productive potential, recommended control devices, and miscellarcours factors concerning streams in Aree 12 (Survey made in 1990)

Name of stream 1/	County, township line, range, and section no. at mouth	Length of stream in miles 2/	width depth of treatment of a stream of the treatment of	Average depth of stream 1/2/	Range in g/gradient 3/	Ranga in velocity in ft./sec. 3/	Tempera- tures in degrees F.	Date	Productive potential	Possible limiting factors	Type of control possible 4/
Kelsey Greek	Berage, 52-33-27	10.25	8.0	0.25	Slight	1.0	56	05/9/6	Small	Spewning sites, obstacles, velocity	Mechanical weir & trup

List includes only thosa streams which appear to heve a productive potentiel or for which control devices have bean recommended.
"Langth" is the measurament of that portion of the stream aurveyed, and is composed of a calculation of map distance plus application of a corrective factor (verieble) compiled from field measuraments. The stream length figures differ from total length in all cases where field conditions terminated the erea usable by sea lampreys short of the

headwaters. Applicable only to the surveyed portion of the stream. From an engineering standpoint, electrical control devices can probebly be installed in all streams for which mechanical devices have been rocommended.

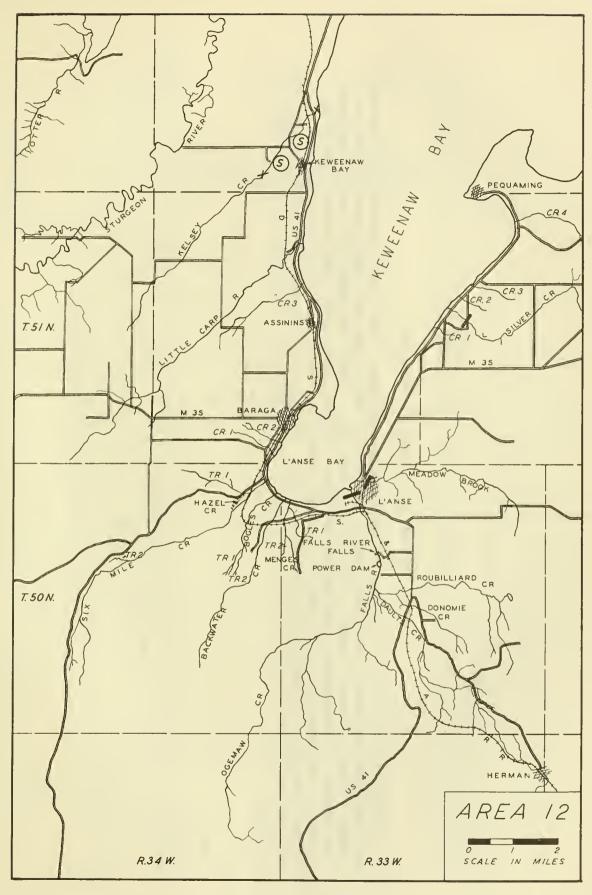


Figure 13.—Area 12.

# Description of Area 12 (Fig. 13)

Embraces a portion of north and northwestern Baraga County, Mich., and contains the watersheds of the Falls and Little Carp Rivers, Little Silver, Backwater, Six Mile, and Kelsey Creeks, and a number of small coastal streams. Only Kelsey Creek has a productive potential; a mechanical conslightly rolling, wet sand plain on the old glacial lake shores. Drainages are poorly defined, and bogs and swamps are common. Soils are light; alder-popple scrub and bog conffers characterize trol device is recommended. This stream is brown in color, has a slight gradient and low water velocity, and contains only a trace of spawning materials. The area is made up of level or the area.

Table 13.--Productive potential, recommended control devices, and miscellaneous factors concerning streams in Area 13 (Survey made in 1950)

	Type of control possible 4/	Electricel	Electrical	િ	\cdot \( \sigma \)	75	ો	/s̄	/5	/5	Weir & trep
	Fossible limiting Factors	Spawning materiels, level fluc.,	obstacles Level fluc., obstacles,	temperature Obstacles, level fluc.,	Level fluc., obstacles,	temperature Obstacles, velocity, spawning materials	Spawoing sites,	temperature Spawoing sites, velocity, obstacles,	temperature Chatacles, temperature	Spawning sites,	Level fluc., velocity, temperature
İ	Froductive potential	None	Large	Large	Large	Sme 11	Medium	्राम्	Small	Small	Medium
	Date	8/29	9/10	9/14	6/6	1	1	-		† 8 †	9/3
	Tempere- tures in degrees F.	60-62	28	252	50-54		:	1	-	E 8 1	52-54
	Range in velocity in ft./sec. 3/	Sluggish-1.5	1.75- ?	1.0 -2.25	1.5-1.75	Sluggish-1.25	0.75-1.5	Sluggish-1.0	1.5-1.75	1.75	1.0-1.5
	Recge in gradient 3/	Slight-moderate	Slight-moderate	Slight-ateep	Slight-moderate	Slight	Slight	Slight	Moderate-steep	Moderate-steep	Slight-moderste
	Average depth of stream in ft. 3/	2° ¢	0.66	0.75	1.0	0.5	0.5	0.5	0.5	0.5	1.0
	Averege width of atreem in ft. 3/	76.0	27,5	35.0	22.0	12.0	14.5	10.0	15.0	0.9	18.0
	Length of stream in miles 2/	0.08	26.0	32.0	26.0	1.75	8.0	1.0	2.25	0.5	8.0
	County, township lice, renge, and section no. et mouth	Houghton, 54-33-33	Berage, 51-34-16	Houghton, 52-34-14	Houghtoo, 51-35-1	Houghton, 52-35-25	Houghton, 53-34-32	Houghton, 53-35-35	Houghton, 51-35-16	Boughton, 51-35-19	Houghton, 53-33-5
	Name of stream 1/	Sturgeon River	W. Br. Sturgeon River	Otter Mver	N. Br. Otter River	Bear Creek	Sante River	Thirteen Greek	Bruno Creek	Lake Fifteen Cr.	Pike Rver

List includes only those streams which appear to heve a productive potential or for which control devices have been recommended.
"Lecgth" is the measurement of that portion of the stream surveyed, and is composed of a calculation of map distance plus application of a corrective fector (vuriable) compiled from field measurements. The stream length figures differ from total length in all cases where field conditions terminated the area usable by sea lamprays short of the নাল

Applicable only to the surveyed portion of the stream. From an engineering standpoint, electrical coetrol devices can prohably be installed to all atreams for which mechanical devices have heen recommended. Stream tributary to another upon which it would be more practical to place a coetrol device. लोक<u>ो</u>ण

headwaters.

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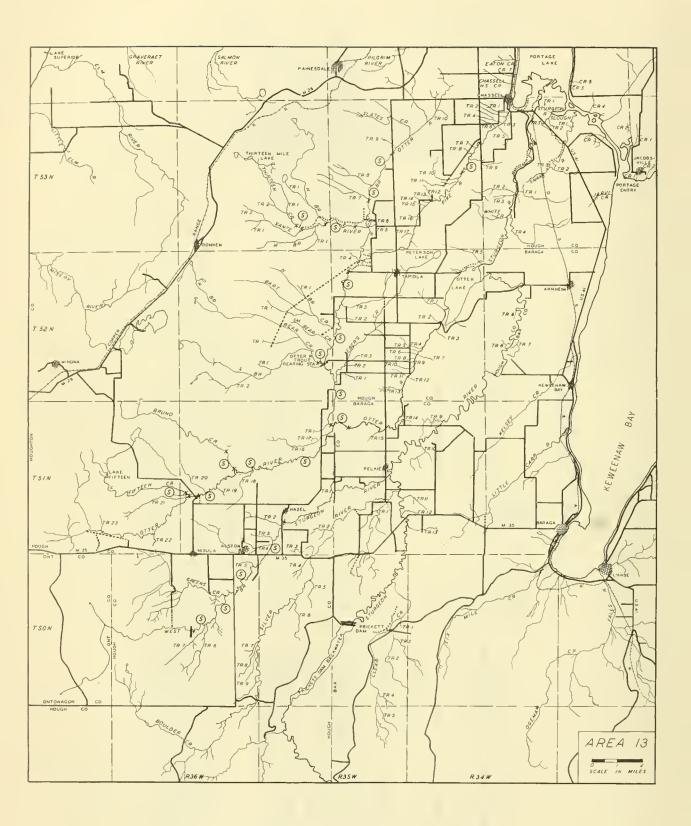


Figure 14.—Area 13.

## Description of Area 13 (Fig. 14)

to steep. Hard-bottom materials are common, but soft components also occur frequently. Much of the Embraces central Houghton County and portions of western Baraga and eastern Ontonagon Counties, facilities. An electrical device is recommended for the Sturgeon; a mechanical structure is suitable for the Pike. The streams of the area are generally brown in color and gradients are slight area lies in the old lake clays region; the topography varies from wet bottoms to rolling hills. Michigan, and contains the Sturgeon, Snake, and Pike River watersheds, and several small coastal The tremendous Sturgeon system and the Pike watershed both contain abundant spawning Forest and agricultural lands occur equally. streams.

Table 14.--Productive potential, recommended control davices, and miscellansous factore concerning etresms in Area 14 (Survey made in 1950)

Type of control possible 4/	Machanical	Electrical	20	kechanical	Mechanical	hechanical weir & trap
Possible limiting factore	Tamperature, obstecles,	lavel fluctuations Level fluctuations, pollution,	distance Spawning sites, velocity, nollution	Obstacles, level fluc., temperature	Obstacles, level	Spewning sites, velocity
Productive	Large	Medium	Sme 1.1	hedium	Medium	Small
Date	8/27-9/4 Large	8/16 & 17 Medium	8/17	0/27	8/27	8/16
Tempera- tures in degrese F.	45-55	56~65	63-64	34-55	54	57
Range in valueity in ft./sec. 3/	1.25-1.5	1.0-1.5	0.75-2.0	1.55-2.0	1.5-2.25	Sluggish-0.5
Ranga in gradient 3/	Slight-moderata 1.25-1.5	Moderate	Slight-steep	3lit-steep	Slight-moderate	Slight
Averege depth of etream	0.66	1.25	0.5	0.5	9*0	1.0
Length Average Average of width depth astream of a stream astream etream aniles 2/ in ft. 3/ in ft. 3/	21.5	27.5	0.0	0.9	6.5	12.0
Length of stream in miles 2/	15,25	12.0	3.25	0.9	0.9	2,25
County, township libe, renge, and section no. et mouth	Houghton, 54-33-5	Houghton, 55-32-5	Houghton, 56-32-32	Houghton, 55-32-5	Houghton, 55-32-18	Houghton, 54-32-22
Name of streem 14	Pilgrim River	Trap Rock River	Hammell Creek	Sawmill Creek	hcCallum Creek	Lahti Creak

list includes only those streams which appear to have a productive potential or for which control davices have been recommended.

"Largh" is the measurement of that portion of the stream surveyed, and is composed of a calculation of map distance plus application of a calculation of map distance plus application of the stream langth figures differ from total length in all cases where field conditions terminated the stream langth figures differ from total length in all cases where field conditions terminated the stream langth figures differ from total length in all cases where field conditions terminated the stream langth figures of the headwaters. नोलो

Applicable only to the surveyed portion of the stream. From neglegate on the stream of the mechanical devices have been recommended. Stream standard, another upon which it would be more practical to place a control device. लाका<u>ल</u>

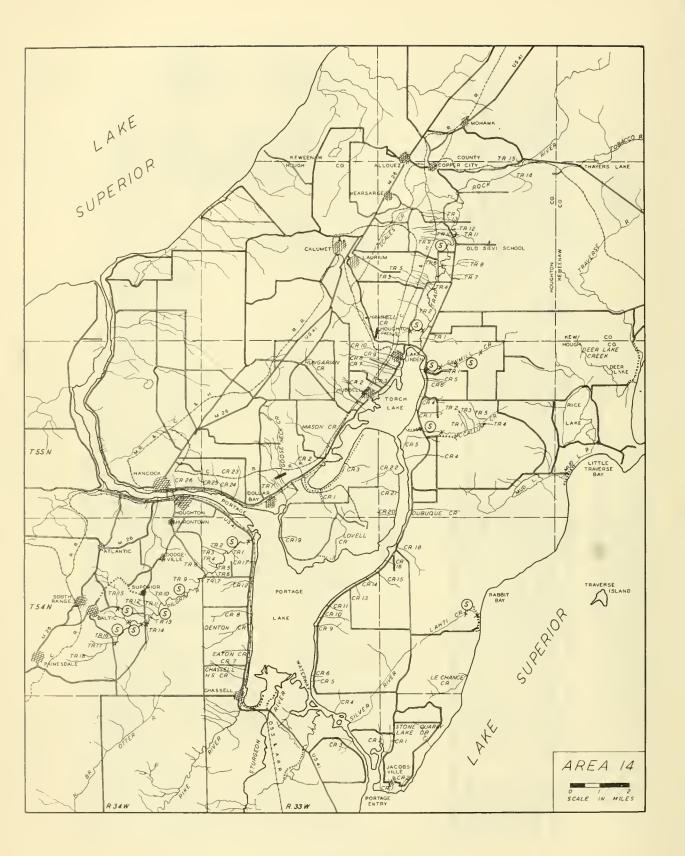


Figure 15.--Area 14.

## Description of Area 14 (Fig. 15)

and contains the watersheds of the Pilgrim and Trap Rock Rivers, Hammell, Lahti, Gooseneck, Sawmill, Rock; an electrical device will be necessary in that stream. The streams of the area are generally and McCallum Greeks, and a large number of small coastal streams tributary to either Lake Superior or the Portage Waterway. Appreciable productive potentials occur in all but Lahti and Gooseneck brown in color and clear (except for some transient turbidity in the Trap Rock due to pollution). Embraces most of the northern half of Houghton and a small portion of Keweenaw County, Mich., Creeks. Mechanical control devices are recommended for all the potential producers but the Trap broken, and drainages are well defined. Agricultural lands predominate in the valleys, but much Gradients range from slight to steep. Mard-bottom materials are plentiful. The topography is forested upland and timbered bog are present.

Table 15.--Productive potential, recommended control davices, and miscellamenue factors concerning estrana in Aree 15 (Survey made 10 1990)

Name of stream 1/	County, townehip line, renge, end arction no, at mouth	Length of etreem in miles 2/	Length Average Average of width depth stream of of of in a stream of in ft. 3/ in ft. 3/	Average depth of etream in ft. 3/	Renge in g/gredient 3/	Fange in Tempera- velocity tures in in ft./sec. 3/ degrees F.	Tempera- tures in degrees F.	Date	Productive potential	Possible limiting fectors	Type of control possible 4/
Traveres Mysr	Houghton, 55-31-4	11.5	13.5	1.0	Slight	1.0-2.25	55-57	55-57 8/14,16/50 Medium	Medium	Spewnlog eitas, fluctuetions,	Electrical
Tobacca River	Кежеелви, 56-30-20	22.0	13.5	1.0	Slight-moderate 0,5-3,5	0,5-3,5	66-68	8/10	Medium	Dustaclas Spawning sites, fluctuations,	Electrical
81g Betsy River	Kawaenaw, 57-30-36	3.5	7.5	1.0	Slight	Sluggish-0.75	62-64	8/8	Small	velocity, obstacles	Mechanical
Little Botsy River	Кежеецаж, 57-29-29	1,75	0.9	0.75	Slight-moderate 0.5-2.5	0.5-2.5	1	1	Small	Spaming sites, fluctuations, obstacles, tempereture	Methanical

List includes only those streams which appear to have a productive potential or for which control devices here been recommended.

"Leagth is the measurement of that profit on of the stream entryeted, and is composed of a catchulation of map distracte plue application of each terminal or that profit of the stream length iffigures differ from t "all length in all cessa where field conditions terminated that are useble by sea lampreys short of the নানা

From as engineering standpoint, electrical costrol devices can probably ha installed in all atreams for which mechanical devices have been recommended. Stream tributary to enother upon which it would be more prectical to place control device. Applicable only to the surveyed portion of the stresm. ला का ज

Figure 16.--Area 15.

# Description of Area 15 (Fig. 16)

devices will also be more suitable in the Betsy Rivers if power lines are made available. The streams Embraces the southeastern portion of Keweenaw County, Mich., and contains the watersheds of the materials are abundant. The topography ranges from low, sandy plains and bogs in the lower water-sheds to rugged, rocky, upland wilderness; glaciated soils and land features characterize the area. Traverse, Tobacco, Big Betsy, and Little Betsy Rivers, and several small coastal streams. All of the named streams are potential sea lamprey producers, but only the Traverse and Tobacco are significantly dangerous. A questionable record of five "probable" nests exists for the Traverse. in the area are generally brown in color and gradients range from slight to steep. Hard-bottom Electrical control devices are recommended for both the Traverse and Tobacco Rivers; electrical Ecological situations are equally varied and complex.

Table 16.--Froductive potential, recommended control devices, and miscellameure fractor concerning extreme in Area 16 (Survey made in 1990)

Name of stream 1	County, township line, range, and section no. et mouth	Length of stream in milee 2/	Length Average Average of width depth of stream of of thream stream etream miles 2/ 10 ft. 3/ 1n ft. 3/	Avarege depth of etream	Renge in g/gradient 3/	Fange in Tempere- velocity tures in in ft,/sec. 3/ degrees F.	Tempere- turae in dagreea F.	Dete	Productive potabilel	Possible limiting fectore	Type of control bossible 4/
Little Gretiot River	Keweenew, 58-29-31	8.5	14.0	1,75	Moderate	1.5-2.0	06-70	2/30	Large	Fluctuetione,	
Elster Creek	Кемеележ, 57-30-4	5.0	0.0	0.5	Slight-steen	Sluggiab-1.5	53	8/2	Snell	obstecles, isolation Spawning sites.	Electrical
Mine The mer Two Cases	0 02 03				440,700					velocity, obstacles	્ર
4					dears-1 marro	0.713	i		11000	temperature	2/
Bear Creek	Кемеелем, 58-28-30	2.0	5.5	0.66	Moderate-ataep Sluggiah-1.0	Sluggiah-1,0	51-53	7/24 &	Small	Spewning sites, fluc.,	1
								8/3		velocity, obstacles,	Mechanical
										tamperature	weir & trap
Hoar Creek	Keweenaw, 58-28-25	2.0	4.0	0.25	Slight	0.5	90	7/27	Small	Spawning eitea,	
										velocity,	Mechanicel
										obsteclea	wair & trap
Union Creek	Кемеелам, 58-27-21	4.5	5.0	0.5	Slight-moderate 0.5-1.5	0.5-1.5	62	7/27	Sme 11	Obstacles	Mechanicel
											weir & trap

List includes only those streams which appear to have a productive potantial or for which control davices have been recommended.
"Leaguh" is the measurement of that partion of the stream eureveyed, and is composed of a caltuistion of map distreame plue application of a corrective factor (veriable) compiled from find a measurement and large and large from total langth in all cases where field conditions terminated the area usable by sea lampreys short of the

Applicable only to the surveyed portion of the etream:
The men supplication of the etream:
The men supplication etablosist, electrical control devices can probably be installed in all streams for which mechanical dayless here been recommended.
Stream tributary to another upon which it would be more practical to place a control device. लाक<u>ी</u> जा

Figure 17.--Area 16.

# Description of Area 16 (Fig. 17)

sheds of the Little Gratiot River-Mendota system, the Montreal River, Bear, Hoar, and Union Creeks, and a number of small coastal streams; all but the Montreal have a productive potential; only the a narrow band of low, swampy, sand plain borders the lakeshore; soils are generally light and thin. only in the Little Gratiot. Characteristically the area is rugged, rocky, mountainous upland, but uniformly brown in color and gradients range from slight to steep. Hard-hottom types are abundant Little Gratiot is considered dangerous. An electrical installation is recommended for the Little Embraces most of the southeastern portion of Keweenaw County, Mich., and contains the water-Gratiot; mechanical devices will be suitable in the other streams. The streams in the area are Coniferous stands in the lowlands and mixed hardwoods on the slopes form the forest cover.

Table 17. -- Potentiel nest sites, productive potential, recommended control devices, end udscelleneoue factore concerning streams in Aree 17 (Survey made in 1951)

		Length	Averege	Average		Pange fr			Mumber			
Name of etream $1/$	County, township line, range, and section no. et mouth		of stream 3/	of stream in ft. 3/	Range in gredient 3/	velocity in ft./sec.3/	Tempereture in degrees	Date	potentiel pest sites Productive observed 2 potentiel	Productive potentiel	Possible limiting fectors	Type of control possible 4/
Lake Fenny Hooe Creek	Кемеевем, 59-28-33	0.5	25.0	1.0	Moderate	1.5	62	7/24	None	0		Berrier dam
Mud Lake Creek	Комеелем, 59-28-34	0.5	15.0	0.75	Slight	Sluggieb	* * 1	}	12	Medium	Temperature	5
Vulcsn Creek	Кежевлем, 59-28-34	0.6	8.0	0.25	Moderate	1.0	61	7/23	25	Medium	Irreguler hottom	\si
Gardeo Brook	Кежеележ, 59-28-32	5.5	8.0	0.2	Slight-moderete	0-1.0	}	1	40	Nedium	Tempere ture,	5/
Glezon Creek	Keweensw, 59-29-31	0.75	3.0	0.2	Slight	0-1-0	;	:	ю	Small	Temperature	Wechenicel
Silver River	Keweensw, 59-30-35	0.7	20.0	1.0	Slight-steep	Sluggish-1.0	57	7/24	100	Large	Tempereture	weir & trep Berrier dem
Little Silver River	Кемеевем, 59-30-35	1.0	3.0	2.0	Slight-steep	0.5-1.0	58	7/24	1	Medium	Temporeture, irreguler	25/
Ceder Creek	Кетеелет, 58-30-5	5.0	0.9	0.5	Slight-steep	0.5	56	7/24	40	Medium	hottom Temperature, velocity, irreg-	Electricel
Elizo Lake Creek	Кемеелем, 58-30-6	1.0	15.0	0.5	Slight-steep	٥ ت	64	7/24	80	Large	ular hotton Velocity	Mechanical weir & trep

"Length" is recorded se twice the calculated map distance (the map distance is usuelly at lesst doubled by the ectual meanders of the stream). List includes only those streams which appear to here a productive potential or for which cootrol devices here heen recommended.

Applicable only to the surveyed portion of the stream. From an engineering standpoint, electrical control devices can probably be lostelled to all streams for which machanical weirs and traps or berrier dems have been recommended. Stream tributery to enother upon which it would be more practical to place a control device.

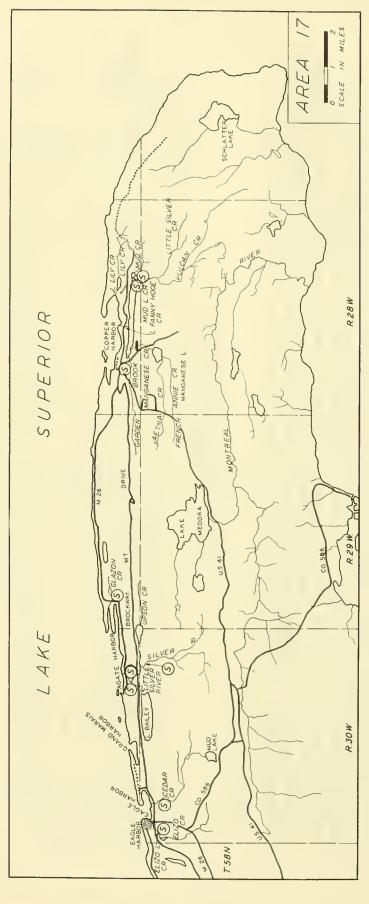


Figure 18.--Area 17.

## Description of Area 17 (Fig. 18)

systems. Some type of control may be required in five of them. The Silver River, Elizo Creek, stream bottoms are largely hard and irregular. Low water temperatures and sudden freshets may fanny Hooe Creek systems may be controlled by concrete barrier dams which can be constructed lampreys; Glazon and Cedar Creeks have facilities for fewer nests. The Silver River and Lake Lake and Glazon Creeks, but an electrical control device will probably be necessary in Cedar and the Lake Fanny Hooe Creek systems appear to be capable of producing large numbers of sea Embraces the northeast portion of Keweenaw County, Mich., and contains six small river on bedrock substrata. Sites for mechanical weirs are present close to the mouths of Elizo gradients are generally steep, and water velocities are high in some stream sections. The Creek because of the low banks. All of the control sites are readily accessible. Stream limit the amount of spawning and the freshets may interfere with control operations.

Table 18 .-- Potential nest sitee, productive potentiel, recommended control devices, and miecellaneous factors concerning atreams in Area 18 (Survey made in 1951)

Name of etraem 1/	Langth Average Average of the conty, township attern of the of line, range, and in the effection no. at mouth miles 2 in ft. 3 in ft. 3 in ft. 3	Langth of stream in milee 2/	Average width of etream in ft. 3/	Averege dapth of atream in ft. 3/	Range in gradient 3/	Range in welccity in ft./sac. 3/	Tempereture in degrees F.	Date	Number of potential nest sites	Productive potential	Possible limiting factore	Type of control possible 4/
Garden City Brook	Кажеелам, 58-31-19	4.0	10.0	0.3	Moderate-steap 1.0	1.0	63	7/25	40	Med1um	Nona	Mechanical
borrison Creak	Кемвелаж, 58-32-26	0.4	20.0	0.2	Slight-steep	Sluggish	19	7/27	22	Medium	None	Electricel
Gratiot River	Кемеелам, 57-33-11	25.0	40.0	0.5	Slight-steep	0.5	90	1/28	£ 002	Large	None	Electrical
Hill Creek	Kemeenam, 57-33-14	18.0	15.0	0.5	Slight-moderate 1.0	1.0	56	7/31	100 ≠	Large	Temperatura	Electrical
Slack Creek	Кемеелят, 57-33-14 14.0	14.0	10.0	0.75	Slight-steep 0.0-3luggish	0.0-3luggish	62	7/31	25	b,edium	Drying	्रो

List includes only those streams which appear to have 9 productive potential or for which control devices have been recommended. "Length" is recorded as twice the calculated map distence (the map distance is usuelly at lesst doubled by the sctuel meanders of the etreem). ज्याला का जा

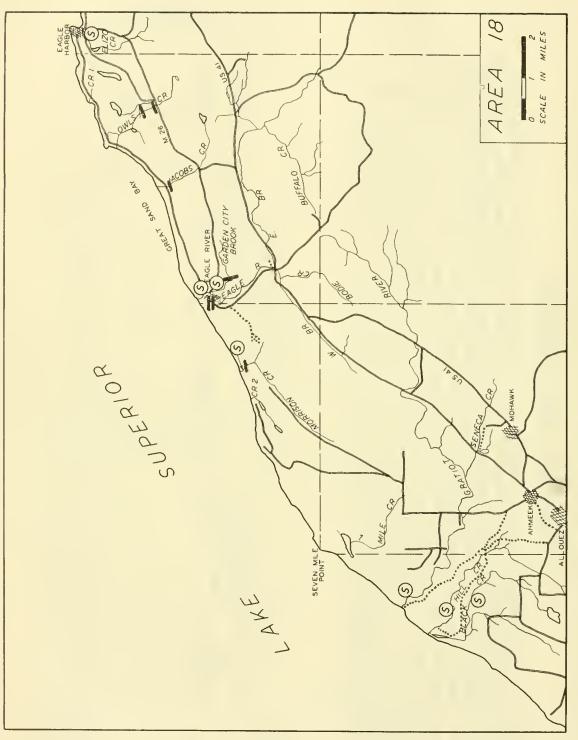
Applicable only to the surveyed portion of the stream.

The surveyed portion of the stream.

The surveyed portion of the stream.

Stream engineering stendpoint, electrical control davices can probably be installed in all streams for which mechanical devices have been recommended.

Stream tributary to another upon which it would be more precised to place a control device.



## Description of Area 18 (Fig. 19)

cal in the other streams; good sites for mechanical weirs are lacking. Morrison Creek is relatively can be constructed close to the mouth of Garden City Brook. Electrical devices will be more practi-Embraces the northwest portion of Keweenaw County, Mich., and contains nine small river systems. for fewer nests (40-50) are present in both Garden City Brook and Morrison Greek. A mechanical weir Abundant spawning facilities are available in the Gratiot River and in the Hill Creek system; sites inaccessible. The stream gradients are generally steep, and velocities are high during the spring. The surrounding country is sandy and rugged. Hardwoods are predominant.

Table 19.--Potential nest sites, productive potential, recommended control devices, and miscellaneous factors concerving atreams in Area 19 (Survey made in 1951)

Type of control possible 4/	Nechebicel	Weil of trap	Weir & trap	weir & trap	weir & trap Lechabical	weir & trap	weir & trap Mechanical	weir & trap   echenical	Welr & trap	weir & trap Electrical	25	Lechanicel weir & trap	Nechabical	Weir & drap Lechanical Weir & trap	Wachanical weir & trap	Bechanical	Electrical	Nechanical	well & trap Electrical	Berrier dem	Elactrical	25	Elactrical
Fossible limiting fectors	Small size, irreg-	Irregular bottom	Temperature,	velocity Valocity	Velocity	Irregular bottom	Irragular bottom	Irregular hottom,	small size Temperature	Temperature	None	Smell size, velocity,	irregular bottom Temperature,	Temperature, velocity, irreg-	ular bottom Temperature, velocity, irreg-	ular bottom Irregular bottom,	Temperature, velocity, irreg-	ular hettom Temparature	None	None	Temperature, valocity, irrag-	ular hottom Temperature,	None
Productive potantial	Snall	Small	Vedium	Medium	h.edium	Madium	Small	3me11	1.edium	Larga	Larga	Sme 11	Wedium	Small	Med1um	ame 11	Smell	Large	Medium	Large	Medium	Large	Nedium
Number of potential pest sites observed	4	4	30	30	9	12	ь	4	25	≠ 00T	£ 002	4	89	ы	65	₫*	4	100 /	12	100 /	20	100 /	20
Deta	7/31	7/31	9/31	7/31	7/31	7/31	8/1	7/31	8/1	8/1	8/1	8/1	8/1	8/1	8/1	8/2	2/8	8/1	8/3	8/6	8/7	8/7	8/8
Temperatura in degress F.	29	63	26	49	09	99	99	61	56	57	61	64	56	55	61	20	54	56	62	54	28	28	09
Range to velocity in ft./sec. 3/	0.5	1.0-3.0	1.5	1.5	1.5	2.0	1.0-2.0	O.O-sluggish	1.0	1.5	1.0	1.0 /	1.0	0.75	1.0 /	0.75	3.0	1.0 /	Sluggiah-1.0	1.5	1.5-2.0	1.0 4	0.0-1.5
Range in grodient 3/	Moderata	Slight-steap	Moderata-steep	Moderata-staep	Moderate-steep	Mo derata-steap	Steap	Moderata-stesp	311ght-moderata	Slight-steap	Slight-steap	Steap	Steep	Steep	Moderate-staep	Slight-steep	Steep	Slight-modarate	Moderate	Slight-steep	Mo derate-steap 1.5-2.0	Slight-steap	Slight-staep
Average depth of stream in ft. 3/	1.5	0.25	0.25	0.25	0.25	0.0	0.3	0.1	0.8	0.5	0.5	0.3	≈00	0.1	0.25	0.1	0.5	0.5	0.25	1.0	0.4	0.8	1.0
Average width of streem in ft. 3/	3.0	4.0	0.9	4.0	2.0	20.0	3.0	3.0	17.0	25.0	30.0	3.0	5.0	8,0	18.0	20.0	25.0	15.0	40.0	25.0	30.0	20.0	35.0
Length of stream in miles 2/	0.0	3.5	1.0	3.0	2.0	6.5	5.0	2,5	0.9	8.0	10.0	2.2	3.0	1.0	0.9	5.0	8.0	8.0	22.0	17.0	26.0	8.0	14.0
County, township line, renge, and section no. at mouth	Houghton, 56-33-5	Houghton, 56-33-6	Heughton, 56-33-7	Houghton, 56-33-7	Houghton, 56-33-7	Houghton, 56-34-12	Houghton, 56-34-13	Houghton, 56-34-13	Houghton, 56-34-14	Houghton, 56-34-33	Houghton, 56-34-34	Houghton, 55-34-4	Houghton, 55-34-9	Houghton, 55-34-16	Houghton, 55-34-28	Houghton, 55-34-35	Houghton, 55-34-28	Houghton, 55-34-8	Houghton, 55-35-20	Houghton, 55-36-35	Houghton, 54-36-30	Houghton, 54-36-30	Houghton, 54-36-31
Name of streem 1/	drewery Creek	Gardenar's Craek	Creek # 1	Greak # 2	Creek # 3	McGunn'a Creek	Smith Creek	Creek # 5	Bear Creek	Boston Creek	Lily Creak	Creek # 1	Creak # 2	Creek # 4	Sweda Town Graek	Creek # 1	Colsa Craak	Schlotz Creek	Salmon Trout River	Graverset River	Elm Hver	South Brench Elm R.	Little Elm River

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List includes only those atreams which appear to have a productive potential or for which control devices have been recorded as twice the calculated map distance is usually at least doubled by the actual meanders of the atream.

\*\*Longth\*\* is recorded as twice the calculated map distance is usually at least doubled by the ectual meanders of the surveyed portion of the stream.

\*\*Room she engineering standpoint, cleatrical control devices can probably be installed in all streams for which mechanical weirs and traps or berrier done have been recommanded.

\*\*Stream tributery to another upon which it would be mare practical to place a control device.

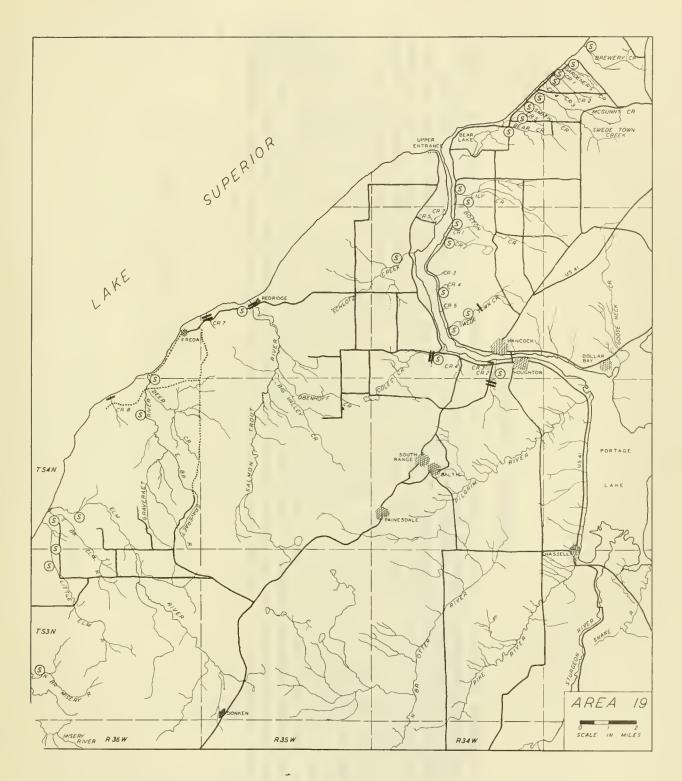


Figure 20.--Area 19.

## Description of Area 19 (Fig. 20)

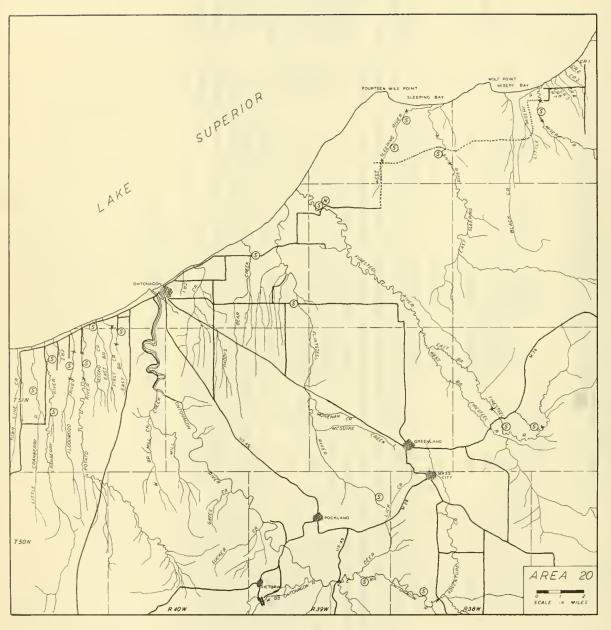
high. Low water temperatures and freshets may inhibit spawning. The large water volumes present in the spring and during periods of heavy rain may interfere with control operations. The country east of the Portage Waterway is generally sandy while morainic formations and lake clays are prethan 5 nests are present in each of the remaining streams listed (table 19). Sites for mechan-Embraces the entire northern coastline of Houghton County, Mich., and the northern portion of the Portage Waterway. Spawning facilities are available in 21 river systems, 8 of which flow of the area. Ten other watersheds each offer facilities for from 6 to 65 nests. Sites for less dominant to the west. The entire area is rugged. The forest climax type is largely hardwood. Schlotz Greeks, tributary to the canal, and the Graveraet and Elm Rivers in the western portion lacking. A concrete barrier dam is recommended for the Graveraet River. The Graveraet and Elm mechanical structures, and for Boston and Coles Creeks in which sites for mechanical weirs are Rivers are relatively inaccessible. Stream gradients are generally steep, and velocities are ical weirs are present near the mouths of 15 streams. Electrical control devices are recominto the Portage Waterway. Abundant facilities are present in four watersheds: Boston and mended for the Salmon Trout, Elm, and Little Elm Rivers, which are too large for practical

Table 20, --Potential meet eites, productive potential, recommended control davices, and miscallaneous fectors concerning streams in Aree 20 (Survey made in 1951)

	Type of control possible 4/	Electrical	Electrical	Electricel	Electrical	Electrical	Mechanical weir & trap	Electrical	Mechanical metr & trep	Mechenical	Electrical	Electrical	Electrical	Electricel
	Fossible limiting fectors	Temperature	None	Tempereture	None	Nobe	Temperature	None	Spewning materiele	Temperature, enemals	Temperature	Tempereture,	None	None
	Froductive potentiel	Large	Large	large	large	Large	Small	Large	Smell	Smell	Large	Large	Large	Larga
Number of	potentiel nest sites observed 3/	80	≠ 002	≠ 00T	≠ 0001	≠ 00T	4	\$ 002	4	4	100 /	75	≠ 00T	≠ 00T
	Date	8/11	8/25	8/24	8/27	8/27	1	8/23	8/22	8/25	8/22	8/25	8/27	8/58
	Temperature io degrees F.	54	99	5.6	72	73	1	28	09	28	58	51 89	64	63
Range in	valocity in ft./sec. 3/	0.0-0.0	Sluggish-1.0	Sluggish-1.5	Sluggish-2.0	Sluggish-0.75	Sluggish-1.0	Sluggish-5.0	Sluggish	Sluggish-1.0	Sluggish-1.0	Sluggieh	Sluggish	Sluggish
	Range in gredient 3/	Slight-moderete	Slight-steep	Slight-moderete Sluggish-1.5	Slight-steep	Slight	Slight-moderete Sluggish-1.0	Slight-steep	Slight-moderate Sluggish	Slight	Slight-moderete Sluggish-1.0	Slight-moderete	Slight-moderate	Moderete
Averege depth	of stream in ft. 3/	2.0	0.5	5.0	1.0	0.9	0.5	2.0	0.5	0.5	2.0	0.5	9.0	1.0
Average width	of etreem in ft. 3/	45.0	0.09	10.0	40.0	100.0	20.0	100.0	10.0	12.0	35.0	20.0	40.0	30.0
Langth	etreem in milee 2/	30.0	30.0	11.0	75.0	33.0	16.0	¥ 00.	14.0	14.0	30.0	17.0	25.0	16.0
	County, township line, renge, and section no. at mouth	Ontonegon, 53-37-10	Cutonegon, 53-38-13	Untonagon, 53-38-13	Catobegon, 52-39-1	Cutonegop, 52-39-2	Optonagon, 52-39-15	Ontonagon, 52-40-25 100 /	Ontonegon, 52-40-34	Ontonegop, 52-40-34	Untonagob, 52-40-33	Untonagon, 51-40-4	Ontonagon, 51-40-6	Ontonegon, 51-40-6
	Name of etream 1	Liaery River	Last Sleeping River	West Sleeping River	Firesteele River	Flintsteele River	Beer Creek	Uptomagon River	First Creek	Second Greek	Poteto River	Floodwood River	Crenberry River	Little Crenberry R.

List includes only those streams which appear to have e productive potential or for which control devices have been recommended.
"Length" is recorded as twice the calculated map distance is usually at least doubled by the octual meanings of the streem.
"Ispinate only to this surveyed portion of the streem of the streem from an engineering standpoint, elactrical control devices probably can be installed in all streems for which mechanical weirs and trops have been recommended. Stream tributary to enother upon which it would be more practical to place a control device. <u> শুলাল্য ক্র</u>াণ্য

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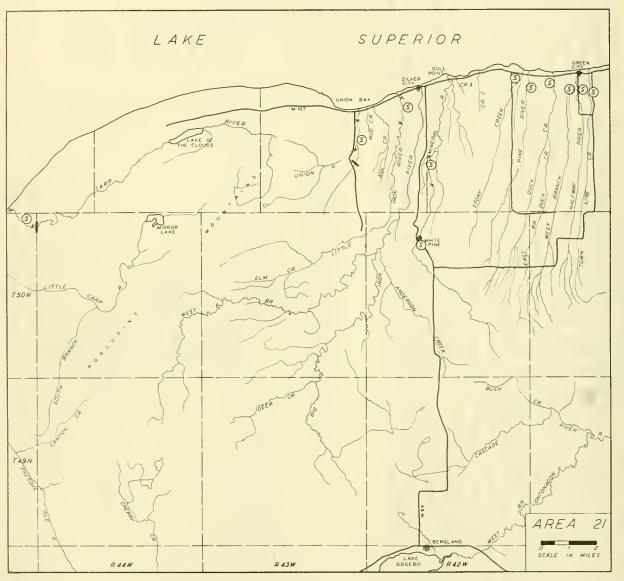
## Description of Area 20 (Fig. 21)

is rugged, and lake clay soils are predominant. The forest climax type is largely hemlock-hardwood. inaccessibility of the three or four suitable streams east of Fourteen Mile Point. The entire area high velocities may limit spawning in some streams. Control operations will be hampered by the electrical control devices are recommended for them. Control may be especially difficult in the during periods of heavy rain, and changes in water levels are rapid. Low water temperatures and Embraces the northeast portion of Ontonagon County, Mich., and contains at least 13 streams Abundant spawning facilities are present in all but three of the streams. Sites for mechanical weirs are present Ontonagon, Flintsteel, and Firesteel Rivers because of their large size. One lamprey nest was observed in the Firesteel River in 1951. Stream gradients are generally steep, and velocities devices. The 10 streams capable of producing great numbers of sea lampreys are all large, and in these three, and the streams themselves are small enough for practical operation of such above the area of "lake level effect" are high. Most of the streams are exceedingly turbid Much of the area has been logged recently and is covered with impenetrable slash and second in which sea lampreys may spawn. The status of Paddys Creek and Creek No. 1 just east of Ontonagon, and of Black Creek just east of Wolf Point is unknown at present. growth.

Tabla 21 .- Fotential neat sites, productive potential, recommended control devices, and miscellaneous factors concerning streams in Area 21 (Survey made in 1951)

Name of stream 1/	County, township line, range, and section no. at mouth	length of atream in miles 2/	Average width of stream 3/	Average dapth of stream 3/	Renga in gradient 3/	Range in velocity in ft./sec. 3/	Temperatura in degrees F.	Dete	Number of potential nest sites	Productiva	Possible limiting factors	Type of control possible 4/
Town Line Creek	Ortonegon, 51-41-1 19.0	19.0	85.0	0.0	Slight-moderate 0.75	0.75	54	9/8	100 /	Large	Tempera ture	Electrical
Halfway River	Ontonagon, 51-41-1	34.0	30.0	2.0	l'oderate-stesp	1.5	23	9/6	100 /	Larga	Temperature	Electrical
Duck Graak	Ontonagon, 51-41-11	31.0	30.0	0.5	Slight-moderata	1,5	54	9/6	98	Larga	Temperatura	Electrical
Pine River	Ontonegoo, 51-41-3	22.0	20.0	1.0	Slight-moderate Sluggish-1.0	Sluggish-1.0	55	9/8	100 /	Larga	Temperature	Electrical
Stony Greek	Ontonagon, 51-41-3	14.0	14.0	0.5	Slight-moderate Sluggish-1.0	Sluggish-1.0	54	9/6	40	hadium	Terperature,	Kechanical
Minaral River	Cntonagon, 51-41-7	24.0	50.0	1.0	Slight-moderate 1.0-2.0	1.0-2.0	61	9/4	£ 092	Large	Temperatura	Electrical
Iron River	Catomagon, 51-42-12	60.0	200.0	į	Moderate-steep	1.0-5.0	-	}	≠ 001	Unknown	-	Electrical
Little Iron River	Ontonagon, 51-42-11	25.0	35.0	0.75	Steap	1.5	52	9/6	7 001	Larga	Temperatura	Electrical
Juion Rivar	Untomagon, 51-42-15 14.0	14.0	40.0	1.0	Slight-steep	Sluggish-2.0	51	8/3	₹ 002	Larga	Tamperatura	Electrical
Carp Rivar	Ontonegon, 51-44-33	30.0	35.0	. 0.8	Moderata-staap	0.5-2.0	53	8/6	35	Medium	Temperatura, irregular bottom	Barrier dam

list includes only those streams which eppear to have a productive potential or for which control davices have been recommended.
"Length" is recorded as twice the calculated map distance (the map distance is usually at least doubled by the actual mesoders of the atream.
Applicable only to the surveyed portion of the atream.
From en enginearing standpoint, electrical cortrol davices can probably be installed in all atreams for which machanical wells and traps or barrier dams have been recommended.
Stream tributary to another upon which it would be more practical to place a control device. <u>ভাগ্যভাগ্য</u>



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## Description of Area 21 (Fig. 22)

mechanical means, and electrical devices are recommended. The Carp River is relatively inaccessible. Stream gradients are generally steep above the areas of "lake level effect," and velocities are high. The large water volumes and resulting heavy turbidity may interfere seriously with control opera-Mud Creeks is unknown. The shoreline from the Carp River east to Union Bay has not been surveyed; with spawning facilities for sea lampreys. At present, the status of the Iron River and Ash and streams (excepting the Carp River in which a barrier can be placed) are too large for control by tions in the spring and during periods of heavy rain. The surrounding country is rugged. Lake Embraces the northwest portion of Ontonagon County, Mich., and contains at least 9 streams potential while two, Stony Creek and the Carp River, have facilities for fewer nests (30 each). A site for a mechanical weir is present just above the mouth of Stony Greek. The remaining several small streams may be present in this area. Seven streams have a large productive clay soils and a forest climax type of hemlock-hardwood are predominant.

Table 22.--Potential nest sites, productive potential, recommended control devices, and miscelleneous fectors concercing streems to Area 22 (Survey made in 1951)

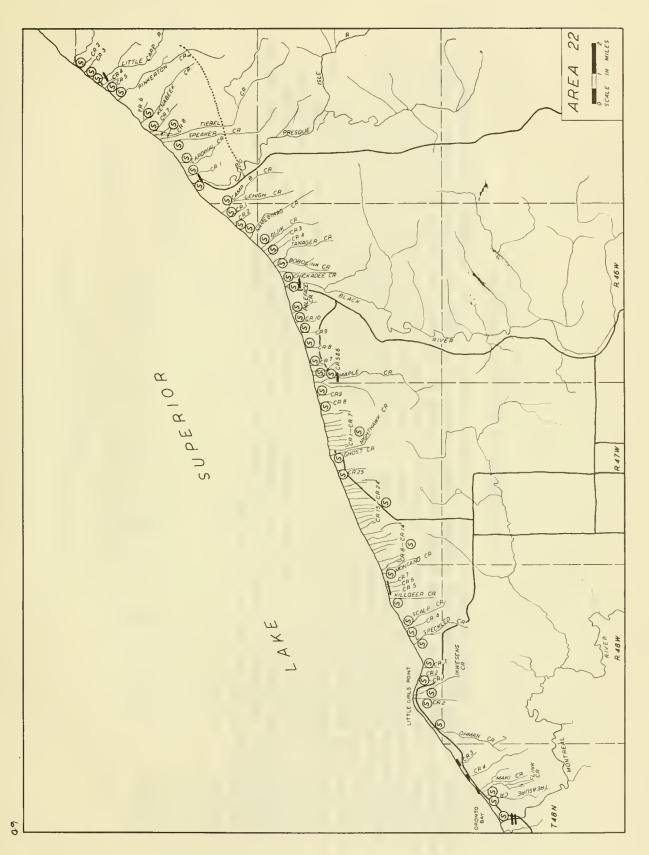
	County, township line, rengo, and	_ s c	0	0		, i	Temperature 1n degreea	N CLO	Number of potential nest sites,	Productive	Possible limiting	Type of control
	section no. at mouth	رة ا	in ft. 3/	in ft. 3/	gredient 3/ r	ला	Bet .		beerved 3/	potentiel	fectore	poesible 4/
Creek # 2	Gogebic, 50-45-2	1.0	10.0	2.0	Slight-moderate	1.0	56	6/6	20	Medium	Tempe re ture	Berrier dem
Creek # 3	Gogebic, 50-45-2	1.0	6.0	2.0	Slight-moderate	1.0	56	6/6	20	Medium	Tempereture	Barrier dam
Little Cerp River	Gogebic, 50-45-2	35.0	35.0	0.8	Moderete-steep	0.5-2.0	56	6/6	100 /	Large	Tempera ture	Barrier dam
Crcek # 4	Gogebic, 50-45-2	1.0	2.0	0.1	Steep	0.75	56	6/6	ক	Small.	Tempereture, aize	Berrier dem
Greek # 5	Gogebic, 50-45-2	1.0	10.0	0.1	Steep	0,75	55	6/6	25	Medium	Tempereture,	Barrier dam
Finkerton Greek	Gogebie, 50-45-10	8.0	30.0	0.5	Steep	1.5	56	6/6	80	Large	Terperature	Barrier dam
Kepebeek Creek	Gogebic, 50-45-16	5.0	15.0	0.25	Moderate-steep	0.5-1.0	56	01/6	15	Kedium	Temperature, velocity, irreg-	Barrier dam
Creek # 7	Gogebic, 50-45-16	3.0	5.0	0.25	Slight	Sluggleh-0.5	56	01/3	25	".edium	uler bottom Temperature	Electrical
Greek #8	Gogebic, 50-45-16	2.0	12.0	0,25	Moderete	1.0	58	9/10	40	Mied1 um	Tempe rature	Electrical
Tiebel Creek	Gogebic, 50-45-16	12.0	25.0	0.5	Moderate	1.0 4	55	9/10	100 4	Large	Temperature	Electrical
Speaker Creek	Gogobie, 50-45-16	8.0	25.0	0.5	Moderate	1.0 4	55	9/10	100 4	Large	Temperature	Electrical
Cerdinel Creek	Gogabic, 50-45-20	3.0	20.0	0.25	Steep	0.5-1.0	53	8/6	12	Kedlum	Temperature, freshets, irreg-	Barrier dam
Creek # 1	Gogebic, 50-45-20	1.0	0.9	0.25	Steep	0.5-1.0	53	8/6	12	Medium	ular bottom Tempereture, fresheta, irreg-	Barrier dam
Big Presque Isle R.	Gogebic, 50-45-19	<b>≠</b> 09	75.0	0	Voderste-stoep	2.0-4.0	5.9	9/13	10	Medium	uler bottom Temperature,	Electrical
Camp 8 Creak	Gogabic, 50-46-25	5.0	20.0	9.0	Stoep	2.0	09	9/13	90	1.edium	Velocity	Electricel
Creek # 1	Gogebie, 50-46-36	1.0	6.0	0.5	Moderate-ateep	2.0 4	58	9/13	30	Medium	Tempereture,	Servior dem
Creek # 2	Cogebie, 50-46-36	1.0	3.0	0.25	Moderate-steep	1.0	28	9/13	30	Modium	Tempere ture	Barri er dam
Namebineg Creek	Cogebie, 50-46-35	5.0	8.0	0.5	Noderate-steep	2.0	58	9/13	80	Large	Tempereture	Barrier dam
Gijik Creck	Cogebic, 49-46-2	4.0	10.0	0.3	Steep	1.0-2.0	56	9/14	20	I edium	Temporature	Electrical
Creek # 3	Gugebic, 49-46-2	2.0	3.0	0.25	Woderete-sterp	1.0	56	9/14	25	hedium	Temperature	Perrier dam
Creek # 4	Gogebic, 49-46-2	2.0	5.0	2.0	Moderete-stasp	1.0	56	9/14	40	Wedium	Temperature	Berrier dam
laneger Creek	Gogebic, 49-46-2	4.0	6.0	0.3	Steep	0.5-1.0	55	9/16	35	Nedium	Temperature	Barrier dam
Bobolisk Creek	Gogebic, 45-46-2	4.0	0.9	0.3	Moderate-steep	0.5-1.0	53	9/15	20	ledium	Temperature	Berrier dam
Chickedeo Creek	Gogebic, 49-46-3	4.0	0.0	0.25	Moderate	1.0	53	8/15	15	hedium	Temperature	Berrier dam
Bleck River	Gogebic, 49-46-3	£ 09	125.0	0.9	Moderate	2.0-3.0	57	9/12	15	1.eq1nm	Tempereture	Electrical
Pelofoce Creek	Gogebic, 49-46-9	0.8	0.9	0.3	Steep	1.0	51	6/16	25	Medium	Tempereture	Barrier dem

		Length	Average	Averege		Renge in			Number of			
Name of atream 1/	County, township line, renga, and section no. at mouth	stream in miles 2/	of stream in ft. 3/	of stream in ft. 3/	Range in Gradient 3/	velocity in ft./sec. 3/	Temperature in degrees F.	Data	potential nest sites observed 3/	Productive Potential	Possible limiting fectors	Type of control pessible 4/
Creek # 18	Gogebic, 49-47-20	1.0-2.0	6.0	0,25	Steep	1.0	54	9/50	25	Ledium	Temperature,	Barrier dam
Creek # 17	Gogebie, 49-47-30	1.0-2.0	4.0	2.0	Medarate	1.0	46	9/25	10	Kedium	Temperature,	Barrior dam
Creek # 16	Gogebic, 49-47-20	1.0-2.0	8.0	0.25	Wederate-steap	1.0	46	9/52	25	Medium	Temperature,	Serrier dam
Creek # 15	Gogebic, 49-47-20	1.0	0.9	0.25	Staep	1.0	48	9/25	20	hedium	Tamperature,	Barrier dam
Craek # 14	Gogebic, 49-47-20	1.0-2.0	2.0	0.1	Moderate	1.0	φ. Θ	9/25	-	Sme11	Tempereture, small size,	Berrier dem
Creek # 13	Gogebic, 49-47-19	1.5	3.0	0.1	Moderata	1.0	46	9/25	4	Small	restats Temperature,	Barriar dam
Creak # 12	Gogebic, 49-47-19	1.0-2.0	6.0	0.25	Moderate	1.0	48	9/25	80	Larga	Termeratura, fresheta	Berrier dam
Craek # 11	Gogebic, 49-47-19	1.0-2.0	2.0	0.1	Steap	1.0	88	9/25	4	Sm. 1.1	Temperature, smell size,	Berrler dam
Creck # 10	Gogebic, 49-47-19	1.0	0.0	0.25	Mederate	1.0	48	9/25	12	Medium	ireauska Temperatura, frasbets	Berrier dam
Creek#9	Gogebic, 49-47-19	1.0-2.0	4.0	0.25	Moderate	1.0	48	9/25	12	Medium	Temperature,	Berrier dam
Craek # 8	Gogebic, 49-48-25	1.0-2.0	10.0	0.25	Noderata-steep	1.0	8	9/58	12	Medium	Temperature,	Barrier dem
Montana Creek	Gogebic, 49-48-25	3.0	12.0	0.3	Woderste	1.0	48	97/56	80	Larga	Temperature,	Berrier dam
Killdeer Creek	Gogebic, 49-48-26	2.5	0.9	0.3	Moderate-stemp	1.5	48	9/56	ß	Small	Temperature,	Barrier dam
Scalp Creek	Gogebic, 49-48-27	3.0	12.0	0.5	Moderate-steep	1.0	45	9/27	2	Medium	Tesueva Temperature,	Barrier dam
Creek # 4	Gogebic, 49-48-27	1.0-2.0	4.0	0.3	Moderate-steap	1.0	45	9/27	г	Smell	Tamperature,	Berrier dem
Little Speckled Creek	Gogebic, 49-48-34	4.0	10.0	0.3	Moders te-steap	1.0	45	6/52	12	l.edium	Tespeta Tespetature,	Barrier dam
Creek # 3	Cogebic, 49-48-33	1.0-2.0	2.0	0.25	Nodersto	0.75-1.0	45	92/3	12	ledium	Tenperature, small size,	Barrier dam
Creek # 2	Gowebic, 45-46-33	1.0-2.0	0.3	0.25	) oderate	0.75-1.0	45	96/6	20	hediun	fresheta Terperature,	Berrier dem
Greek # 1	Gogebic, 49-48-33	1.0-2.0	0.9	0.2	Acderete	0.75-1.0	51	9/19	2	l edium	Tresneta Temperatura,	Electrical
Ikresena Creek	Gogebic, 49-48-32	3.0	6.0	0.25	Moderata	0.75-1.0	52	9/19	10	Wedlum	Temperature	Electrical
Creek # 2	Gogebic, 49-48-32	1.0-2.0	10.0	0.3	Moderate	0.75-1.0	53	9/19	9	Medium	Temperature	Electrical
Chman Creck	Gogebic, 49-48-31	0.9	8.0	0.3	hoderate-sterp	1.0	54	6/52	25	muibe a	Temperatura	Berrier dam
Flink Creek	Gogabic, 48-49-11	3.0	8.0	0.3	Noderate-stamp	1.0	56	9/52	25	N.edium	Tempere tu re	Berrier dam
Tressura Crask	Gogebic, 48-49-11	4.5	10.0	0.3	Moderata ateap	1.0	54	9/55	12	Medium	Temperature	Berrier dam
Montreel River	Gogabic, 48-49-10	20 4	100.0	3.0	Slight-ateap	Sluggish-3.0	252	9/22	വ	Small	Temperature, spewnieg materiala	Electrical

List includes only those streams which appear to bave a productive potential or for which control devices have been recommended.
"Length" is recorded as twice the calculated map distance is usually at least doubled by the actual meanders of the stream).
Applicable only to the surveyed portion of the atreem.
From an engineering standpoint, electrical control devices can probably be installed in all streams for which mechanical weirs and trape or barrier dama have been recommended.
Stream tributery to enother upon which it would be more practical to place a control davice.

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		Length	Average	Average								
	County, township	of atream	width of	depth of		Range in vclocity	Tempe re tu re		Number of potential			
Name of stream 1/	line, range, and section no. et mouth		atream in ft. 3/	stream in ft. 3/	Range in gradient 3/	in ft./98c. 3/	in degrees F.	Dete	nest sites observed 3/	Productive potential	Possible limiting factors	Type of control possible 4/
Creck # 10	Gogebic, 49-46-9	1.0	0.9	0.3	Steep	1.0	52	6/12	25	Medium	Temperatura,	Barrier dem
	Gogebic, 49-46-8	1.0	4.0	0.25	Steep	1.0	52	9/17	25	Kedium	Temperature,	Barrier dam
œ	Gogebic, 49-46-8	1.0	4.0	0.2	Steep	1.0	54	9/12	25	Medium	Temperature,	Barrier dam
4	Gogebic, 49-46-7	1.0	2.0	0.2	Steep	1.0	52	9/17	10	Medium	Temperature, freshets,	Barrier dem
9	Gogebic, 49-46-7	1.0	1.0	0.2	Steep	1.0	1 1	1	ы	Small	small size Temporature, freshets,	Barrier dem
ວ	Gogebic, 49-46-7	1.0	3.0	2.0	Steep	1.0	51	9/17	44	Smell	small siza Temperature, fresbets,	Barrier dem
Maple Creek	Gogebic, 49-46-7	0.6	25.0	0.5	Steep	2.0	51	6/17	30	hedium	email aize Temperature, fronhoto	Barrier dem
O3	Gogebic, 49-47-12	1.0-2.0	4.0	0.25	hoderate-steep	1.0	S2 DII	9/18	¢4	Fall	Termets Temperature, freshets	Barrier dam
89	Gogebic, 49-47-12	1.0-2.0	6.0	0.25	Moderate-steep	1.0	52	9/18	12	Wedium	Temperature, freshets	Berrier dam
4	Gogebic, 49-47-13	1.0-2.0	3.0	0.2	Moderate-ateep	1.0	53	9/18	es.	Small	Temperature,	Barrier dam
Q	Gogebic, 49-47-14	1.0-2.0	3.0	0.2	Moderate-steep	1.0	52	9/18	es.	Small	Tempereture,	Barrier dem
Ω	Gogebic, 49-47-14	1.0-2.0	6.0	0,25	Moderate-steep	1.0	53	81/6	82	Small	Temperature, freshets	Berrier dem
4	Gogebic, 49-47-14	1.0-2.0	6.0	0.25	Moderate-steep	1.0	54	9/18	20	Medium	Terperature, freshets	Parrier dem
ಣ	Gogebic, 49-47-14	1.0-2.0	6.0	0.25	Moderate-steep	1.0	. 25	8/18	4	Small	Temperature,	Berrier dem
es.	Gogebic, 49-47-14	1.0-2.0	0.9	0.25	Moderate-steep	1.0	51	9/18	15	Ledium	Temperature, freshets	Barrier dam
п	Gogebic, 49-47-14	1.0-2.0	3.0	2.0	Moderate-ateep	1.0	52	9/18	12	Medium	Temperature, small size, freshets	Barrier dem
Wighthawk Croek	Gogebic, 49-47-15	3.0	2.0	0.3	Moderate-steap	1.0	51	9/18	10	Nedium	Tempereture, freshets	Barrier dam
Ghost Creek	Gogebic, 49-49-15	3.0	10.0	0.25	Moderete-steep	1.0	52	9/18	12	Ledium	Terperature, freshets	Berrier dam
25 '	Gogebic, 49-47-15	1.0-2.0	4.0	0.25	Moderate	1.0	99	02/6	က	3rs 11	Temperature, freshets	Barrier dem
Creek # 24	Gogebic, 49-47-16	1.0-2.0	10.0	0.25	Moderate	1.0	25	9/30	15	Medium	Temperature, freshets	Sarrier dam
23	Gogebic, 48-47-16	1.0-2.0	0.0	0.25	Noderete	1.0	24	02/5	ю	Small	Temperature, freshets	Barrier dam
222	Gogebic, 49-47-16	1.0-2.0	8.0	0.25	Moderate	1.0	57	02/6	52	Ledium	Temperature, fresheta	Barrier dam
21	Gogebic, 49-47-16	1.0-2.0	4.0	2.0	Slight	1.0	57	9/20	12	Medium	Temperature,	Berrier dam
Greek # 20	Gogebic, 49-47-20	1.0-2.0	0.4	0.0	Steep	1.0	i	}	25	Ledium	Temperature,	Barrier dam
Creek # 19	Gogebie, 49-47-20	1.0-2.0	6.0	0.25	Steep	1.0	22	9/50	23 23	Kedium	Temperature, freshets	Barrier dam



## Description of Area 22 (Fig. 23)

many streams. Freshets, turbidity, and inaccessibility will offer problems in most of the Streams Big Presque Isle, Black, and Montreal Rivers are very large, and electrical devices will probably provide the only practical means of control. Barriers can be constructed close to the mouths which spawning facilities are present. Seven streams, the Little Carp River, Pinkerton, Tiebel, when control devices are constructed. The surrounding country is rugged. Lake clays and a hem-Greek in the western portion each contain facilities for 75 or more nests. Facilities for 6 to periods, turbidity is high. Low water temperatures and sudden freshets may inhibit spawning in 75 nests are present in 53 streams. Sixteen streams contain sites for only 1 to 5 nests. The Speaker, and Namebinag Creeks in the eastern portion of the area, and Creek No. 13 and Montana stream gradients are generally steep, and velocities are high. Heavy rains tend to raise the water levels or a number of streams to the point where they overflow their banks. During such Embraces the entire coastal area of Gogebic County, Mich., and contains 76 watersheds in electrical devices are also recommended. Many of the streams are relatively inaccessible. (and below all spawning grounds) of all but ll of the remaining streams; for the latter, lock-hardwood climax type are predominant.

Table 23,--Summary of information showing utilization of streems from the Tabquamenon River west to the tip of the Keweenew Feninsule, 1950, and from the latter point to the Kichigan-Wisconein border, 1951

			2	te obtei	Dete obtained by survey	ey			Data from other cources
Name of etresm	County end T-R-S et mouth	Number edults found	Date	Number nests found	Date	Larvee	Date	Identification of larves 3/	
Tahquamenon River	Chippewe, 48-6-14	f09	6/29/50	10	6/29/50	0	:	:	Upetream migrents (adulte) reported seen (resort owners) in springs of 1948 and 1949. (1649 run largest-reached peek in 2nd week of June.)
Little Two Hearted River	Luce, 50-9-24	0	:	0	:	16 1/	7/5-7/11/50	Native lampreys	:
Two Heerted River	Luce, 50-9-27	0	:	0	:	O <sub>4</sub>	7/11-7/25/50	Netive lampreys	<del>\frac{4}{4}</del>
E. Br. Two Hearted River	Luce, 49-10-1	0	:	0	:	16	7/27-7/28/50	Netivs lampreys	\frac{1}{6}
W. Br. Two Hearted River	Luce, 49-9-6	63	7/29/50	64	7/25-7/28	25 2/	7/30-7/31/50	4 see end 21	1/4
N. Br. Two Hearted River	Luce, 48-11-1	0	•	4	05/02/2	9	7/28/50	native lampreys Native lampreys	:
Sucker River	Alger, 49-13-4	0	:	23	8/7-8/22	43	8/7-8/17/50	Netive lampreye	:
Baker Creek	Alger, 49-13-4	0	:	0	:	est.	8/29/50	Native lempreye	:
Tributery # 4	Alger, 48-13-1	0	•	0	:	est	8/18/50	Native lampreys	:
Creek # 3	Alger, 49-13-6	0	:	3(7)	8/9/50	0	:	:	:
Hurricene Creek	Algar, 49-15-3	0	:	0	:	8	8/22/50	Native lampreys	* * *
Lowney Greek	Alger, 48-16-17	0	:	7	9/10/20	S	9/10/50	Native lampreys	:
Tributery # 16	Alger, 48-17-29	0	•	0	:	63	9/14/50	Native lampreys	:
Mosquito River	Alger, 48-18-25	0	:	0	:	ы	9/14/50	Native lampreys	:
Miner's River	Alger, 47-18-3	0	:	п	9/8/20	0	:	•	:
Anna River	Alger, 46-19-2	0	:	0	:	മ	9/16/50	Native lampreys	* *
Furnace Creek	Alger, 47-19-29	0	:	0	:	:	:	:	Dead edults observed (resort owners) on beach at mouth of etreem, serly emmer, 1950.
Creek # 7	Alger, 47-19-18	0	:	0	:	1	9/18/50	Unidentifieble	:
Au Trein River (lower)	Alger, 47-20-19	0	:	0	:	٦	05/02/6	Native lamprey	Five adulte and 2 neets observed, July 9, 1950. $5/$

Table 23, continued

			12	ta obtain	Data obtained by survey	707			Doto Prom Other courses
	1,	* Mimber	3	Number	ממי מו מויי	603			Tara Trom ordar sonres
Name of stream	County and T-R-S at mouth	adulta found	Date	nests	Date	Larvea	Date	Identification of larvee $\frac{3}{2}$	
Rock River	Alger, 47-21-15	0	÷	0	:	0	:	:	Severel edults observed (resort owner) below dem at mouth, spring, 1950.
Laughing Whiteflab River	Alger, 48-22-26	0	:	0	:	0	:	Native lempreys	Ten nests observed, and 4 lervae dug, July 10, 1950, $\frac{5}{4}$
Chocolay Rivar	Marquette, 47-24-6	0	:	0	:	0	:	Native lamprays	Approximately 15 edults, 113 lervee, and approximately 265 nests observed and/or recovered from 8/9 tbrough $8/23/50$ , $\overline{5}/$
Cedar Creek	Marquette, 47-24-9	0	:	0	:	0	:	Native lamprey	One lamprey larva recovered, 9/20-28/50. $5/$
E. Br. Chocolay River	Marquette, 46-24-14	0	:	0	:	0	:	:	Five nests observed $9/14$ and $9/15/50$ . $\overline{5}/$
Euron River	Baraga, 52-29-18	0	:	0	:	0	:	Unidentifiable	Six larvae dug, September 1, 1950, $\overline{5}/$
Ravine River	Baraga, 51-31-4	0	:	0	:	0	:	2 native lampreys;	2 native lampreys; Thirteen larves dug, August 31, 1950, 5/
Slata River	Baraga, 51-31-8	0	:	0	:	0	:	ll unidentifiable Unidentifiable	Six probable mests observed, and 5 larvae dug, August 31, 1950. $\frac{5}{2}/$
Silver River	Beraga, 51-31-18	0	:	0	:	0	•	l netive, 21 un-	Ten nests observed, and 22 larvae dug, Auguat 31, 1950, 5
Sturgeon River	Houghton, 54-33-33	0	:	0	:	S	8/29/50	identificats Native lampreys	:
Traverse Hver	Houghton, 55-31-4	0	:	0	:	0	:	:	Five grobable nests observed, July 6, 1950. 5/
Tobacco River	Кемеелам, 56-30-20	0	:	0	:	8	8/28/50	Native lampreys	•
Firesteele River	Ontonagon, 52-39-1	0	•	г	8/27/51	0		•	:

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One of the 5 taken from the stomach of an 8.5 inch brook trout.

A number of larves were also taken on Akgust 8, 1950 from 10 see lampray mests with a square foot bottom sampler. These had been hatched only a short time previous to date of collection, and are assumed to be see lamprays.

Nethod of identification may be in need of further refinements to assume complete accuracy.

Nethod of identification may be in need of further refinements to assume complete accuracy.

Nethod of identification may be in need of further refinements to assume complete accuracy.

Nichlean Department of Conservedior. The figures 80 and 15 represent the total number of specimena taken from the 3 rivers listed above.

Uses reactions by last broken Research Blologust in charge of bequester, idention office, fish and Wildlife Service.

#### LEGEND FOR MAP AREAS 1-22 (SEE FIGURES 2-23)

SPOT LOCATIONS:
ADULT SEA LAMPREYS
LARVAL SEA LAMPREYS
SEA LAMPREY NESTS
SPAWNING HABITAT

NESTS OR SPAWNING HABITAT IN EXTENSIVE AREAS

NATURAL BARRIER
MAN-MADE BARRIER

\* Ø

GOOD ROAD
POOR ROAD

BASE MAPS: MICH. DEPARTMENT OF CONSERVATION, COUNTY MAPS

#### Control procedures

Control devices may have to be installed on 194 or more streams between the Tahquamenon River and the Michigan-Wisconsin border. Tentative sites have been located on the majority of the streams, subject to change as warranted by conditions on individual streams and future developments of control devices.

The majority of streams in possible need of control are small (5 to 15 feet in width). A considerable number are in the 15- to 35- foot class. However, at least 57 are large or very large (tables 1-22).

Electrical devices have been recommended for 65 streams which are too large for mechanical weirs or barrier dams or in which good sites for such devices are lacking. Many of these sites are some distance (several miles) from the nearest power lines. Mechanical weirs are recommended for 61 streams, although it is possible that this type of device will be discarded in favor of more practical structures on individual streams (Applegate and Smith, 1951).

Barrier dams are recommended for 68 streams, many of which are difficult of access. Most of these streams are located in Ontonagan and Gogebic Counties. Banks are ravine-like and the substratum at the potential barrier sites is bedrock. Gradients are generally steep; it is believed that mechanical weirs would be difficult or impossible to hold due to the sudden rises in water levels following heavy rains. A number of these barrier dams can be constructed on bedrock outcroppings which are already partial barriers.

Beyond the usual engineering problems accompanying the installation of control devices, the main problem to be faced in the Lake Superior basin is that of relative inaccessibility. Many potential control sites are miles from the nearest roads, and can be reached only by compass course through rugged areas often covered with almost impenetrable slash and second growth.

The control program in Lake Superior logically should be initiated by constructing control devices in those watersheds in which adult sea lampreys, nests, or sea lamprey larvae have already been observed. At the close of the 1951 season these watersheds numbered 15. At the recommended control sites, the main streams of eleven of these watersheds are large, three are of moderate size, and one is small. Details concerning utilization in these particular streams are presented in table 23.

#### Recommendations for future work

It will be necessary, in the future, to recheck all streams with a productive potential, to determine whether or not they are being used by adult sea lampreys. It is probable that a large number of these streams will never be in need of control measures; spawning may be inhibited by low temperatures, steep gradients, high velocities, relatively small size of a number of streams, and excessive turbidities (lake clay areas of Ontonagon and Gogebic Counties). The more questionable or marginal streams should be rechecked during the regular spawning season to determine accurately their temperatures, velocities, and water levels. The true extent of spawning activity in many streams (notably in Ontonagon and Gogebic Counties) can be determined only by rechecking during the spawning season before most of the nests are destroyed by freshets.

It will be necessary also to carry out further initial surveys of all of the remaining unsurveyed streams flowing into Lake Superior, if the sea lamprey is to be successfully controlled (Wisconsin, Minnesota, Ontario streams, and those on Isle Royale and other islands which have not yet been examined). Many of the unsurveyed areas are relatively inaccessible, and will call for much more highly organized surveys than those carried out to date.

Despite the fact that various types of control structures have been recommended for streams which have a productive potential, it will be necessary to experiment further in order to develop the most practical types. Many Lake Superior streams have characteristics (steep gradients, high velocities, rapid fluctuations in water levels, and extremely heavy turbidity) which, when combined with relative inaccessibility, may present control problems not encountered in previous experimental control operations (Applegate and Smith, 1951).

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